JUN 1 1933

The Research Quarterly

of the

American Physical Education Association

Vol. IV MAY, 1933 No. 2

Published March, May, October, and December

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Ann Arbor Michigan

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Published March, May, October, and December

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Box 362, Ann Arbor, Michigan

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The Philosophy of the Dance*

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INTRODUCTION

THE DANCE is commonly thought of by the laity as a popular form of amusement, combining social and physical elements, yet appealing solely to a frivolous mood. However, history reveals that the dance has played various rôles in the lives of peoples of every age and state of culture. Before man arrived at the stage of reflective thinking, it was the chief mode of expression of certain interests, for the individual, as well as for the tribe. A phenomenon in human life which has been universal in manifestation and persistent through the ages must have deep-seated roots in the inherent nature of human beings.

An investigation such as is proposed in this thesis should attempt analytically to discover the dominant psychological motive or motives in each mode of dance expression, and to trace these back to basic behavior patterns. The endeavor should be to discover what impels the individual to dance; or rather, since the dance impulse is obviously not simple but complex, what are the physiological and psychological factors which enter into the motivation of the various movements called the dance.

Man is a dancing animal, and has always used the dance as a vehicle for the expression of impulse and emotion. Among primitive peoples it was often used as a substitute for articulate thought. Even when man arrived at the reflective stage of development, however, even when the sciences and formal arts appeared, the dance did not disappear but merely took on new forms. It has continued to be a language, which, like music, is an expression of the whole personality through emotion. The dance is one of the arts of self-expression.

When other means of self-expression arose, why did not the dance die out? What is there in the dance that satisfies? Why do we dance? These questions raise the psychogenetic aspect of our problem, and lead directly to the study of the behaving organism and its needs, for satisfactions are evaluations of needs fulfilled. In some way the human organism has always found some type of satisfaction in dance-behavior.

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*Author's Note.—This study was made as a graduate thesis under the supervision of Dr. T. G. Duvall of the Department of Philosophy at Ohio Wesleyan University. The author is deeply indebted to Dr. Duvall and also to Dr. George W. Beiswanger for his valuable aid in the compilation of the chapter on the "Historical Survey" and on the "Dance as an Art."

The procedure is inductive; not from the definitions to the facts, but rather from the facts to definitions, hypotheses, and principles. To bring a unified, coherent view into the varied facts of dancing gathered from anthropology, history, and social psychology; to be able to account for the different modes and rôles played by dancing as variants of a few basic factors working together; to trace the determining factors causing these variations; and to explain why the dance-forms of human behavior satisfy organic needs—to succeed in accomplishing this would be to succeed in giving a "Philosophy of the Dance."

I

THE HISTORICAL SURVEY OF THE DANCE

Some form of the dance has existed in all ages and in all places. To cite examples at random, the Abyssinians in Tigre, the Fijian Islanders, the African Zulus, the Eskimos of Alaska, the Bushmen of Australia, the American Indian tribes, as well as the peoples of ancient civilization, all incorporated some type of dance-behavior into their customs and traditions. While the importance of the dance in the social scale of values has fluctuated from time to time, it has uniformly continued to be an organizing center for various types of social behavior. In tracing the origins of social institutions we find the dance has taken its place as a factor in political organizations, marriage institutions, warfare, and other major interests of humankind. To have done so it must have arisen from motives deeply rooted in human life, for its widespread occurrence renders impossible any theory of diffusion from a single source. The facts leave room for but one hypothesis, that inherent drives and native interests in the mental organism under stimulating conditions take the specific form of dance-behavior.

In this connection it is of interest to note that the dance in every age and country took character from the prevailing motives of the times. Among primitive tribes, in its earlier forms, it served utilitarian, religious, or social ends. Whether the dances were religious or magical, imitative or more distinctly dramatic in nature, they were tied up with primitive urges and organic needs. The events in everyday life connected with work, love, war, the chase, birth, and death furnished the occasions for this form of primitive expression. The dances themselves were no mere performances of a casual nature. They were serious affairs, characterized by vitality of treatment and depth of truth and sincerity. They possessed a dynamic and spontaneous quality which often rose to the intense abandon of savage ecstasy. As G. Stanley Hall has said:

> "Savages are nearly all great dancers, imitating every animal they know, dancing out their own legends, with ritual sometimes so exact that error means death."[1]

With advance in civilization, the motives became refined and more

[1] G. Stanley Hall, *Adolescence*, Volume I, p. 214.

complex. Among the Egyptians the dance developed into religious and spectacular ballets performed by a professional caste. The overflow and recession of the Nile was the great regulatory force in a culture built upon the fertility of the land. As a consequence, the dance was used to invoke and to propitiate the constellations which were believed to control the activities of the river. This recurring theme was put into the form of a ritual in which the death and re-birth of a god, known as Osiris, was interpreted through the medium of the dance. The annual performance of this rite was believed to be the symbolic reassurance of a bountiful food supply. Another outstanding feature of the Egyptian religious ballet was ancestor worship.

In Greece, the dance grew from crude beginnings into an expression of a profound philosophy of life. With no definite conception of a life after death, the Greeks were chiefly concerned with life in this world; accordingly, they concentrated their efforts upon making this life as lovely as possible. Love of beauty and reverence for the human form as the abiding place of the soul centered a great deal of attention upon physical fitness. A beautiful body and the ability to dance well were believed to be indicative of a high state of culture. By this criterion the stage of an individual's spiritual development was judged. For these reasons the dance was an integral factor in the Hellenic scheme of education and religion, as well as the source of their dramatic and poetic art. When the civilization of the Greeks declined, their dance, since it was expressive of their particular ideals, could not be understood or appreciated by an alien civilization. It lost its spiritual quality and survived only in a distorted or decadent form.

The Romans had their indigenous types of dance, the religious and the military. But the conquest of an empire turned their minds from provincial customs to foreign policies. Moreover, the Roman mind was incapable of appreciating the spiritual and philosophic qualities in the Hellenic art which they tried to adopt. The Greek dance, in particular, they degraded into an artificial imitation of its technique. As the culture of the Romans themselves deteriorated, the dance, too, degenerated into an obscene type of entertainment performed by professional dancers who were for the most part imported from abroad. The degradation of the dance during this period was indicative of the depths to which the culture and civilization of this nation had descended.

During the early years of the Christian Era and until after the Middle Ages, secular dancing in Europe was almost suppressed. Attention was centered upon the life in the hereafter, rather than in the here and now. Under conditions dominated by an ascetic view of life, the dance could exist only in a staid, conventionalized form as a part of the religious ceremonies. Yet in spite of this emphasis upon other-worldliness, it continued occasionally to burst forth as a spontaneous form of amusement.

During the Middle Ages and the Renaissance, although the dance continued its close affiliation with the ritual in the churches, it was introduced by the nobility into their festivities as a popular form of recreation. From this custom the highly polished and affected court dance and the spectacular ballet gradually evolved. At the same time there developed among the peasants a natural and exuberant form of folk activity which afforded a welcome relief from the strenuous and serious work of the field and the shop. This vigorous and crude release of pent-up energy and spirit became expressive, in time, of hopes and aspirations as well as of commonplace occurrences. It was known as folk or national dancing because it was the unreflective expression of the spirit and life of the masses.

At the beginning of the eighteenth century the romantic tendency asserted itself in the dance by a decided reaction against the prevailing emphasis upon etiquette, solemnity, and piety. Noverre, a zealous reformer of the ballet, attempted to revitalize the stiff, conventional artificiality which had heretofore characterized it. He endeavored to introduce a more dramatic element; to reduce the elaborate splendor to a controlled type of simplicity; to harmonize the dance, costumes, and scenery with the music. The great classic composers, Bach, Handel, Haydn, Mozart, and Beethoven, all composed music for various types of the dance, and even incorporated some of these forms as integral parts of the sonata and symphony. Yet, in spite of this ability of the dance to inspire great music, it remained a charmingly decorative form of art with the emphasis placed upon daintiness and affectation. The French Revolution diverted the attention of the French people from the development of the dance, and it degenerated into a form of amusement which served as a relief mechanism for all types of humanity.

The emphasis of the nineteenth century upon the importance of the middle class, the rise of industrialism, and the marked restraint which was placed on morals were reflected in the dance. The ballet which had been transplanted from France to Russia about the beginning of the previous century now began making rapid strides in its new environment. The Russian government had established and subsidized two schools of the ballet in which any talented child might receive instruction, provided the quota of the institution was not already filled. It was now possible to study the dance as an art-form, and the opportunity to acquire an understanding of the related arts was also provided. Toward the latter part of the century there was a decided attempt to revolt against the old-time traditions, and to introduce a new element of freedom into the ballet.

During this same period, in contrast to the artistic development of the dance, there existed a popular type of stage dancing which included any novel or sensational feature that might please an audience. As a

consequence, the dance was often exploited for commercial gain. When it began to cater to low tastes it was often connected with disreputable people and practices. For this reason the disapproval of many persons was aroused, and religion condemned the dance as an activity unworthy of sanction. Yet, it is significant to note that this opinion was called forth through no fault of the rhythmic activity itself, but rather through the use made of it by uncouth minds.

The twentieth century spirit of individualism and freedom was the essence of the art of Isadora Duncan, the pioneer interpreter of a new conception of the dance. She endeavored to lead the way to an interpretation of modern life similar to, but by no means an imitation of, the Greek ideal of living. She had the courage and vision actually to break down the traditional shackles which had previously bound the dance and to emphasize beauty and a natural form of expression. The inspiration for dance themes was derived from the greatest of the world's music, and from the attempt to understand and to appreciate both art and philosophy. It is of interest to note that although her influence was world-wide in scope, the Americans were slower to approve and to value her work than were the Europeans.

Today, the same spirit continues to guide the dance through the complex manifestations of a scientific and mechanized culture. In Germany under the leadership of Von Laban and Mary Wigman, the modern dance is being given a solid scientific interpretation. In America, the philosophy of Instrumentalism is finding in the dance one of its apt modes of expression, both from an educational point of view, and from an endeavor to render an artistic type of entertainment. The former is under the leadership of Miss Margaret H'Doubler of the University of Wisconsin; the latter movement is led by Martha Graham, Charles Weidman, and Doris Humphrey of New York City. Yet the continuing vitality of the dance as a lower type of entertainment, and also, as a pleasing form of amusement is evidenced by the prevalence of dancing acts in vaudeville, and by the popularity of the social dance today.

This resumé, brief as it has been, points to the universality and the persistence of the dance as one form of life manifestation. One of its earliest investigators has said:

> "No form of activity is more universal than the dance, which is not only intense but may express chiefly in terms of fundamental movements, stripped of their accessory finish and detail, every important act, volition, sentiment, or event in the life of man, in a language so universal and symbolic that music and poetry seem themselves to have arisen out of it."[2]

The dance as a persistent form of rhythmic activity has been instrumental under varying conditions, as a manifestation of religion, as a socializing force, as an expression of both physical and spiritual love, and as an art-form. It has occurred among primitive tribes as well as in

[2] G. Stanley Hall, *Adolescence*, Volume I, p. 211.

highly developed stages of culture; it has been participated in by priests of religion, and by every class of society from palace to hovel; and always as a motor expression of what is psychologically and socially significant. These various rôles of dance-behavior which have arisen to dominant influence at different periods in history, form the basis for the subsequent discussions.

II

THE PSYCHOLOGICAL COMPONENTS OF THE DANCE

Why do we dance? The hypothesis that there are impulses, or determining tendencies, deeply rooted in human nature, which are called forth in dance-behavior, necessitates a psychological investigation of a genetic order. To avoid ambiguity, since psychologists do not at present agree regarding the nature of certain basic psychological assumptions, it becomes necessary to state the writer's psychological point of view. The position taken in this thesis is a form of behavior psychology,[3] rather than a form of mentalism or of behaviorism. We understand and explain the mental life in terms of behavior as the progressive adaptation of the organism to the environment. Consequently, the mental life comprises the subjective or conscious aspect, but also the physiological and biological aspects as well. In this conception of the mental life every mental fact is at the same time a neural fact. The living, functioning organism is the vital, basic fact in the explanation of the psychological problems to be considered. In the compact formulation of Warren, "Mental life comprises the events which occur in the give and take between the organism and the environment."[4] Now, an organism, as organism, because of its inner organization, has certain native tendencies or impulses to activity which point to organic needs. Whenever a deficiency is felt, the nature of the organism is such that it tends to realize this need by striving to find satisfaction; and the gratification of an organic need is realized in terms of movement. Satisfaction is derived from kinaesthetic sensations arising from internal rhythmic movements and from glandular or emotional changes; and also, from the external type of response which is expressed through overt movement.

There is, of course, no dance-instinct; nor is there a specific prepotent reflex which accounts for the dance-impulse. Every act, every movement in human life springs from, and represents the organism as a whole, even when some parts are more immediately and more vitally concerned in the behavior. It is the organism which is behaving, and that behavior is in some fashion determined by the internal organization of the self. On account of its physiological and anatomical arrangements, the organism

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[3] T. G. Duvall, *The Intelligence Function*, forms the basis for the psychological point of view in this discussion.

[4] Howard C. Warren, *Human Psychology*, p. 1.

has certain mechanical possibilities of behavior. The nervous system is such that behavior-responses of certain acquired patterns of varying degrees of complexity are constantly being called forth by stimuli. We find that instead of being a simple element, the dance-motive is a complex fusion of several simple elements, the majority of which have been acquired. Throughout the history of the dance there has been a continual shift in the stress or emphasis placed upon these various constituents. At one time one element will be the controlling factor, again that factor will relinquish its important rôle, and another will for the time dominate. The character of the complex structure changes with this shift in ascendancy among the various motives, and accounts for the great variety in the type of dance-behavior which is manifested at the different levels of culture. When an integrated response is called forth in answer to a stimulus, the satisfaction to be derived from it is not of a specialized type, but is all-pervasive in character. Dance-behavior is a total organic manifestation as the entire organism enters into the activity with a dynamic force in which all of the elements blend. What are these elements?

The primary elements entering into dance-behavior can, in their last analysis, be reduced to four components: the muscular activity accompanying response to organic need; the hunger impulse; the sex impulse; and the fighting impulse. The dance, as all the other arts, no doubt came into being in connection with some urgent, utilitarian need of the organism. Probably the first dance was simply a series of vigorous, spontaneous, and uncoordinated movements expressive of strong emotion. Man's need for an adequate food supply centered his attention first upon the means for procuring this material necessity. Hunting dances were found to be valuable as a means of developing skill for the actual encounter, and also as a means for obtaining a magical power over the desired prey. The dance came to be the vehicle for anticipating, or commemorating a bountiful food supply; and the ensuing celebration became an integral part of the ancient customs and traditions.

Undoubtedly, primitive man sought the companionship of others not merely for the sake of protection and for the increased opportunity of securing an adequate food supply, but also because of the unconscious functioning of the sex drive, since there is a natural desire on the part of human beings to gain the favor and approval of their fellows. The dance was especially adapted to inciting the love and approbation of the opposite sex, as it afforded an opportunity to display skill and physical prowess.

With the rise of settled communities, and the consequent amassing of personal and tribal possessions, offensive and defensive warfare took on established form, with its own customs and traditions. War dances were instituted for the purpose of frightening the enemy, for developing

the necessary skills involved in the battle, and for inciting and heightening the desired aggressiveness.

Aesthetic determinants were gradually creeping in, however, and the original, primary utilitarian values were transformed through a persistent process of orientation. Even after a study of the history of an art it is impossible to determine just when this change takes place.[5] The play-impulse which Patrick has defined as any free, spontaneous activity pursued for its own sake,[6] was probably one of the earliest manifestations of this process of transformation. Play is accompanied by the feeling of elation or pleasure which results from the unrestrained "expression of surplus energy," "when an exuberant life is excited to action." [7] "All art, therefore, can in a certain sense be called play." [8] The motive to self-gratification through the sensuous delight in rhythmic activity, enjoyed for its own sake, now entered the dance-impulse as a decisive factor. Prall has said:

> "Then without the war or the labor to call for the beating of the drums, or the cries of encouraging ferocity, or the exciting dances stimulating the emotions into bravery or action, the rhythmical movements and sounds in the recognized structures of music or dances could be produced simply for their own sake, their affective magic transformed into natural enjoyment."[9]

Sumner and Keller have stated:

> "After the essentials of livelihood are taken care of, self-gratification expands into a powerful factor."[10]

This play-impulse added to the dance an element of variation, of diversity and an enlarged scope of interest and appeal. The impulse of self-adornment, originally springing from the desire to frighten one's enemies, yielded in the development of the dance to the play-impulse, with consequent aesthetic effects. There was an increasing endeavor to gain a bold, decorative effect by means of ornamentation; elaborate designs were painted on the faces and bodies of the dancers. Oftentimes in the war-dance a horrible and grotesque "make-up" was believed to be efficacious in scaring the imaginary enemy. The decorative dance, it is believed, was an outgrowth of this impulse, but no doubt it was the outgrowth of the spiritual impulse, as well. As civilization advanced, beauty assumed a central rôle, and the desired effects were gained through a harmony of sound, color, and line.[11] This type of dance took the form of processionals, ceremonials, and eventually developed into spectacular pageants, and finally the interpretative dance.

The impulse to expression found its outlet in the primitive gymnastic

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[5] Yrjo Hirn, *Origins of Art*, p. 14.
[6] George T. W. Patrick, *Psychology of Relaxation*, p. 47.
[7] Johann Schiller, *Poems of Schiller*, also *Aesthetical and Philosophical Essays*, p. 120.
[8] Yrjo Hirn, *Origins of Art*, p. 28.
[9] D. W. Prall, *Aesthetic Judgment*, p. 52.
[10] Sumner and Keller, *The Science of Society*, Volume III, p. 2158.
[11] Louis Flaccus, *The Spirit and Substance of Art*, p. 81.

dance which placed strength, agility, and skill in the central rôle of importance. The dancer was concerned with vivifying and intensifying his familiar motor life, with building a world which was expressive of his own energy. In character it was vigorous, and at times quite violent. The stunt element often entered in, while twists, stamps, spins, and various gyrations were the main vocabulary of movement. In the corroborries of Australia this type of dance is exemplified.[12] This impulse led into an elaboration of the dramatic presentations of love, war, and religion, in which the imitative impulse was prominent. Such a type of dance transcended the plane of mere imitation, however, and became expressive of the purposes and capacities of the dancers. Feelings, emotions, and ideas were projected into the rhythmic movements first for the purpose of communication or commemoration; gradually, they came to be expressed for their own sake.

The art-impulse is the vital determining factor in the transition from algedonic to aesthetic values in the dance-motive. According to Carleton Noyes the origin of any art lies in the consciousness of a need which is sufficiently strong to compel a creative response. "Expression rises out of our deepest need, and the need impels expression."[13] There is a definite gradation of values leading from the level of physical or sensuous needs to those of a higher, spiritual quality.

> "In order to understand the art-impulse as a tendency to aesthetic production, we must bring it into connection with some function, from the nature of which the specifically artistic qualities may be derived. Such a function is to be found, we believe, in the activities of emotional expression."[14]

Mere random, incoherent leaps, springs, vaults, or skips express the purest form of primitive feeling. When these movements are regulated by a definite time sequence, the simplest of all art-forms comes into being.[15] Probably the first dance was merely the outburst of a strong emotion, perhaps of joy, or of exultation, with a concomitantly spontaneous activity of the muscles. This simple, primitive dancing was, in the terminology of Wundt, movement expressive of the emotions, which he designated as mimetic and pantomimetic activities.[16]

An emotion has been defined as a "disruption of the normal state of poise and control which is characteristic of intellectual behavior."[17] The condition is the result of a temporary breakdown in the adjustment segment due to overstimulation of cortical centers; the "normal channel of the impulse is impeded," and the reaction is "dispersed over many motor tracts."[18] It is a complex situation in which the whole organism is

[12] Ernest Grosse, *The Beginnings of Art*, p. 208.
[13] Carleton Noyes, *The Gate of Appreciation*, p. 15.
[14] Yrjo Hirn, *Origins of Art*, p. 29.
[15] *Ibid.*, p. 87.
[16] Wilhelm Wundt, *Outline of Psychology*, p. 192.
[17] T. G. Duvall, *The Intelligence Function*, p. 30.
[18] *Ibid.*, p. 31.

involved. The visceral and glandular systems are called into activity, and the organism assembles its reserve forces in the effort to cope with the challenging situation which called forth the response. We have, then, in emotion a type of behavior, which more than any other type, is consciously total in its organic character. An emotion is an "all over experience."

Max Meyer[19] and also Carr[20] have contrasted intelligent behavior with emotional behavior. The latter is wasteful, impulsive, confused, or awkward, while the former manifests itself in a coordinated, smooth, efficient manner. Mental development is made possible through the acquired control-mechanisms regulating the organism's spontaneous activities. But rational control, dependent always on systems of ideas and systems of values, is of notoriously slow growth. Among primitive and backward peoples then the rational type of control-systems must be anticipated by a prerational type, which is essentially emotional. What regulating influence tends to control behavior until the mental life is sufficiently developed to assume stable control through ideas and ends? According to Wundt:

> "Not the epic song, but the dance, accompanied by a monotonous and oft times meaningless song, constitutes everywhere the most primitive, and in spite of its primitiveness the most highly developed art. Whether as a ritual dance, or a pure emotional expression of joy in rhythmic, bodily movement, it rules the life of primitive man to such a degree that all other forms of art are subordinate to it." [21]

Here we have in rhythm a type of mental organization, which, in its simplest form (rhythmic movement) occurs as a reaction-pattern or a behavior-pattern, which precedes the acquisition of the higher types of behavior-patterns known as meanings and values. It is assumed at this point that there is in the organism a native determining tendency to throw experience into certain rhythmic forms and that the resulting rhythmic movements are sensuously pleasing.

Rhythm has been defined both from an objective and subjective point of view. Coleman[22] and Harris[23] have stated that it is any phenomena recurring at approximately equal intervals. Bock has added to this definition an element of stress:

> Rhythm is "any series of regularly recurring activities amongst which a regularly recurring differentiation occurs, as by accentuation or otherwise, and irrespective of whether such movements have conscious rhythmical accompaniments or not." [24]

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19 Max Meyer, *The Psychology of the Other One*, p. 212.
20 H. A. Carr, *Psychology*.
21 Havelock Ellis, *The Dance of Life*, p. 36–37. Quoted from Wilhelm Wundt, *Völkerpsychologie*, 3rd edition, 1911, Bd. 1, Teil 1, p. 277.
22 Walter Coleman, "The Psychological Significance of Bodily Rhythms," *Journal of Comparative Psychology*, I (1921), 213.
23 D. F. Harris, "On Rhythm," *Scientific Monthly*, X (1920), 309.
24 Carl W. Bock, "The Neural Correlates of Instincts and Habits," *American Journal of Psychology*, XXX (1919), 377.

But not all students of dance phenomena have been innocent of psychology. Isaacs, Swindle, and Sonnenschein appropriately recognize that there are elements in rhythm other than mere periodicity.

"Rhythm is the experience arising from the periodic, pendular, reflex response of characteristic organs to objective stimulation." [25]

Swindle[26] emphasized both the temporal, objective factor and the subjective, patterned arrangement. Sonnenschein in his definition of rhythm stresses the importance of the mental response of the individual concerned:

"Rhythm is that property of a sequence of events which produces on the mind of the observer the impression of proportion between the duration of the several events, or groups of events, of which the sequence is composed." [27]

Wundt defines rhythm "as an emotion arising from the feelings of expectation and satisfaction," [28] which in his view involve kinaesthetic sensations of tension and relaxation. Miss H'Doubler follows Wundt, indicating the organic character of rhythm in both its subjective and its objective aspects as the "pick up and release of energy."

"She thinks of pick up and release of energy in terms of intensity of muscular movement, and also in terms of the accompanying mental states, particularly the accompanying kinaesthetic sensations." [29]

The facts from the more recent studies in rhythm lead to the conclusion that mere periodicity is not per se rhythmical. Experiments show that a series of tones of equal intervals and equal stress may be heard in a variety of rhythms, according to the will of the hearer. We have already noted that there is a native disposition to group conscious events into rhythmic patterns. Aside from the voluntary grouping just mentioned, the mental determinants of one's experiences of rhythm are one's acquired dispositions and attitudes.[30] Factors which are involved in the grouping are temporal relationships (duration), intensity, and quality or pitch.[31]

Rhythm regulates the energy output of the organism and tends to bring a number of motor impulses into the unity of a definite mental pattern by introducing an element of motor control, a regulated recurrence or sequence. Rhythmic movements are smooth, even, calculable, in contrast to the nervously expensive, jerky movements of a non-rhythmic nature. When groups of people are involved in the same type of work various occupational songs arise to increase the pleasure and

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[25] Eleanor Isaacs, "The Nature of the Rhythmic Experience," *Psychological Review*, XXVII (1920), 296.

[26] P. F. Swindle, "Time, Perception and Rhythm," *Psychological Bulletin*, XVII (1920), 244–49.

[27] E. A. Sonnenschein, *What Is Rhythm?* p. 16.

[28] Wilhelm Wundt, *Human and Animal Psychology*, p. 377.

[29] Clarence Ragsdale, *The Psychology of Motor Learning*, p. 27.

[30] Watson and Simpson, Thesis on the Pre-School Child, University of Wisconsin, 1928.

[31] Clarence Ragsdale, *The Psychology of Motor Learning*, p. 31.

efficiency of working together, harmoniously, and in unison. The words are more or less meaningless, there is practically no tune, but the dominating element is the rhythmic swing. These facts all go to prove the thesis that if bodily movements in heavy manual labor are regulated by rhythm, the effort involved is lessened; the movements tend to become automatic; and the necessity for mental effort in controlling the muscular effort is eliminated. Armies since the time of primitive man have marched in unison because rhythm conserves both physical and mental energy.

Even though we find in rhythmic procedure a gain in the efficiency and economy of effort, this in itself does not explain why it is pleasurable. Rhythm brings bodily and mental movements to an automatic status, but not all automatic movements are pleasant; mere automatism is not hedonic. The sense of pleasure arises from another factor—from the feeling of self-expansion and power which results when a movement-situation is controlled. Since the coming movements are predicted, the elements of suspense, fear, or dread are eliminated. The organism is given the sensation of being borne along on the crest of a wave. This swing and exhilaration commonly known as the "carrying-power of rhythm" has a two-fold effect. On the one hand it reduces the labor and toil, while on the other there is a sense of exaltation, of being lifted up, and of gaining a mastery over the existing conditions; for these reasons rhythm has the capacity to rest and refresh the human organism. J. J. Findlay has said it is satisfying because it "encompasses the relations between the body and soul of man." [32]

In investigating the causes why we dance, why, in all stages of culture man has always expressed his emotions and his impulses in some form of dance, we are led to the hypothesis that there is a determining propensity in the nature of the human organism which tends to express feelings and emotions and ideas by means of overt, rhythmic bodily movements.

> " . . . when excitement has induced a rapid oxidization of brain tissues," rhythmic muscular movements are the "physical exertion by which the overcharged brain is relieved." [33]

This unimpeded expression of the self calls forth a pleasurable response in the organism. According to Dr. Duvall, "the determining principle in the development of value-experiences and attitudes (which category would include the dance as an art-form), is the distinction between 'agreeable' and 'disagreeable,' and the corresponding selectiveness and response." [34] There is a hedonic basis for all aesthetic experiences, for we are so constituted that we tend to repeat those activities which are pleasurable, and to avoid those which are painful. All great

[32] J. J. Findlay, *Rhythm and Education*, p. 1.

[33] Smith and Young, article on "The Dance," *Encyclopedia Britannica*, 13th edition, Vol. 6, p. 795.

[34] T. G. Duvall, *The Intelligence Function*, p. 28.

art, however, transcends the world of material values and focuses its attention upon those of a spiritual quality. If the dance had not fulfilled a definite functional need of man, first on the level of utilitarian satisfaction, then upon a higher plane wherein it contributed a form of intrinsic value, it would have disappeared by the very laws of natural selection. Its survival as an art-form bespeaks its value as one of the instruments of modern culture.

"If we are indifferent to the art of dancing, we have failed to understand, not merely the supreme manifestation of life, but also the supreme symbolism of the spiritual life . . . The significance of dancing, in the wide sense, thus lies in the fact that it is simply an intimate, concrete appeal of a general rhythm." [35]

III

THE RELIGIOUS MANIFESTATION OF THE DANCE

An investigation into the history of religions reveals that even among primitive peoples the root tendencies of the religious impulse manifest themselves in the dance. All through the history of the developing religious consciousness, we will find the dance coming in to aid the religious subject in the manifestation of his religious emotions, for, as has been shown, ordered movements or gestures were the precursors of cultural ideas. At all times, and in all ages, deep emotional experiences overpass the capacity of ideas to express them. Religion always has been and probably always will be at root a deep-seated feeling about life and the universe. These feelings or experiences often burst forth in song and in dance, so that ever since the beginning of civilization we see that the dance has been a persistent form of expressing religious feeling. It has served the purpose of administering to the religious soul in its deeper moods.

It is the purpose of this section to exhibit some of the facts furnished by the history of religion to establish the thesis that mankind, in its struggle to give expression to the felt needs of life, and particularly in the struggle to give outward form and expression to the religious feelings within, impulsively sought that expression in movements and postures which finally took form in the rhythmic movements of the dance. And in the history of the later ethical religions, this dance-motive was not eliminated, but only restrained and transformed; thereby enhancing the sense of beauty and meaning of religion—a beauty and meaning which we can always feel but never completely put into ideas and words.

The religious consciousness, we find, is not a ready-made construction of ideas given to man, but is rather an evaluational attitude which springs out of his life-long struggle to discover and to retain the significant and worthwhile experiences in life. Patrick has designated it as

" . . . a feeling of dependence upon the unseen powers which control our destiny, accompanied by a desire to come into friendly relation with them." [36]

[35] Havelock Ellis, *The Dance of Life*, p. 34-35.
[36] George T. W. Patrick, *Introduction to Philosophy*, p. 29.

Havelock Ellis defines "the quintessential core of religion as the art of finding our emotional relationship to the world conceived as a whole."[37] The religious experience exists, according to Hoffding, in the "relation between reality and value"; in the "effort to conserve value."[38]

This evaluational process rests upon an underlying feeling-tone, which contributes to religious consciousness the capacity to deal with the deeply pertinent and vital problems of life, as it calls forth a total response from the entire organism. Primitive religion did not exist in order to interpret prevailing ideas; it arose prior to the appearance of ideas in answer to certain functional needs. It actually "performed values." [39] It was the earliest manifestation of an integrating force whose object was to organize life's values and to express them collectively.

Religious experience at this stage was distinctly a social affair, for the entire tribe was collectively concerned in its expression. To this collective emotional factor Jane Harrison[40] has attributed the origin of both art and ritual. Gradually, out of this desire to repeat, in collective form, the effective activities involved in the planting and harvesting of the crops or in hunting, and the pleasure to be derived from the utterance and dancing of weird incantations, the ritual arose.

> "All the ceremonies require dance, chants, surprises, explosions of energy, before they become effective. The efficacy of the group is greatest in this climax of emotion and it is then that the magic is wrought. At that moment power is communicated, the processes of nature are enlivened, the youth is transformed into manhood, sickness is expelled, the evil doer is detected, the enemy is smitten, the future is foreseen, and all manner of miracles are wrought." [41]

Doubtless the first religious dance arose out of primitive man's feelings of veneration, awe, and fear of the unknown. He evidently felt an urgent need to place himself upon friendly relations with the supernatural powers that he believed were controlling the changes in his environment.

What was more natural than for this naïve, childlike person to feel that he could please these beneficient or malevolent spirits by imitating what he believed were their activities? It is to this imitative propensity in mankind and his urgent desire to be in accord with the controlling forces in the universe that Dr. Oesterly[42] has attributed the origin of the sacred dance.

Before man had definite ideas of spirits he had great faith in the efficacy of magic. As a consequence the primitive dance was closely allied with magic of an imitative, sympathetic, or coercive nature. Innumerable instances of the use of imitative magic to compel the supernatural powers, or the gods, to answer prayer are to be found in Frazer's

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[37] Havelock Ellis, *The Dance of Life*, p. 182.
[38] Harold Hoffding, *The Philosophy of Religion*, pp. 219 and 216.
[39] George A. Coe, *Psychology of Religion*, p. 89.
[40] Jane Harrison, *Ancient Art and Ritual*, p. 26.
[41] Edward S. Ames, *Psychology of Religion*, p. 93-94.
[42] W. O. E. Oesterley, *The Sacred Dance*, p. 15.

Golden Bough. To produce rain, to insure the fertility of the crops, or to be successful in finding game, pantomimic dance ceremonials which imitated the desired situation were employed. In times of great need the rites became more barbarous.

"When game was very scarce, certain Basuto tribes which lived partly by the chase, were wont to assemble and invoke the spirit of a famous dead chief and other ancestral deities. At these ceremonies they cut themselves with knives, rolled in ashes and uttered piercing cries. They also joined in religious dances; chanted plaintive airs, and gave vent to loud lamentations. After spending a whole day and night in wailing and prayer, they dispersed next morning to scour the country in search of the game which they confidently expected the ghosts or gods would send in answer to their intercession." [43]

In Madagascar while the men are away fighting, the women at home dance day and night in order to instil into their husbands the necessary courage and strength to insure a victory.[44] The same principle is involved in the war dances in which the warriors attack the images of their enemies, and believe this has the effect of destroying or at least of weakening, the strength of their foes.[45]

The ecstatic dance was the outcome of a particularly strong religious emotion. It was believed that the individual was hereby enabled to fuse his identity with that of the supernatural to such an extent that the unusual powers of the gods could be temporarily attributed to the human being. The soul was thought to depart from the body which became, for the time being, the dwelling place of the divinity. The movements began quietly; gradually they increased in vigor and intensity, and a tremendous amount of nervous energy was generated as greater and greater demands were made upon the physical powers. Finally, the climax was achieved when the wild, abandoned movements subsided into a state of semi- or total unconsciousness. At this stage the individual was believed to be immune to pain and the ordinary dangers of life, yet endowed with the supernatural power for prophesying, effecting cures, et cetera. The devil-dancers of Ceylon, the Bodo and Fijian priests,[46] the Siberian shaman, the medicine-man of the American Indians, and the prophets of Baal, all employed this method to bring on their inspirational spells.

As we come to consider later developments of the religious consciousness, involving the subsequent dominance of the ideational element over the naïve, pictorial processional and festival, the dance-motive is retained, although its function is restrained and sublimated. The Egyptians held sacred ballets in their temples in honor of their deities, and the priests used the dance as a means for instilling higher ethical standards of conduct into their worshippers.[47] By means of definite figures, steps, and

[43] G. J. Frazer, *The Golden Bough*, Folk Lore, Vol. III, p. 277.
[44] *Ibid.*, p. 131.
[45] Edward S. Ames, *The Psychology of Religious Experience*, p. 78.
[46] E. Tylor, *Primitive Culture*, Vol. II, p. 133–4.
[47] Daniel Mason, *The Dance*, p. 9.

rhythmic movements, they represented the impressive regularity and harmonious activity of the celestial events. India and Japan also used temple dances as an essential part of their worship.[48] We find several instances in the Old Testament which point to the use of the dance as a form of worship:

"Praise Him with timbrel and the dance." [49]
"Let them praise His name in the dance." [50]
"And David danced before Jehovah with all his might." [51]
"The daughter of Saul looked out of the window and saw King David leaping and dancing before Jehovah." [52]

Among the ancient Hebrews we find that the dance was also the instrument used to express great joy and thanksgiving:

"And Miriam the prophetess, the sister of Aaron took a timbrel in her hand; and all the women went out after her with timbrels and with dances. And Miriam answered them, 'Sing ye to the Lord, for he hath triumphed gloriously; the horse and rider hath he thrown into the sea.' " [53]

The dance as a means of showing honor to the supernatural powers or to a particular deity, can be traced from the ceremonials of savage times, through the Greek mysteries, the Egyptian Festival of Osiris, the medieval May Day festivities to the present day ritual of St. Mark's-in-the-Bouwerie in New York City. Among savage, uncivilized groups, or individuals of a low level of intelligence, the expression often assumed a frenzied, ecstatic form; while for individuals whose conduct was regulated by more intelligent guidance, it assumed a calmer, more restrained form.

Dr. Oesterley,[54] an English doctor of divinity, feels that the ecstatic dance was the medium employed by the Old Testament prophets for identifying themselves with the deity, and thereby receiving the power and wisdom to utter oracles. Even though oftentimes no specific mention is made of the dance, he bases his hypothesis upon the fact that the musical instruments used as the accompaniment for the dance were mentioned, and he further feels that the dance was such an ordinary occurrence as a part of all religious ceremonies, that its presence was implied rather than specifically mentioned. The following quotation seems to infer the use of the dance as a method for acquiring the ability to utter oracles:

"That thou shall meet a band of prophets coming down from the high place, and in front of them the harp, and drum and pipe and lyre, and they shall be prophesying." [55]

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[48] *Ibid.*, pp. 26 and 35.
[49] Bible, Psalm 150:4.
[50] *Ibid.*, 149:3.
[51] Bible, II Samuel, 6:14.
[52] *Ibid.*, 6:16. Also I Chronicles, 15:29.
[53] Bible, Exodus, 15:20–21.
[54] W. O. E. Oesterley, *The Sacred Dance*, p. 108.
[55] Bible, I Samuel, 10:5–6.

The "limping dance of the Canaanite priests of Baal" was of an ecstatic nature, the object of which was to compel their God to send rain in order to relieve the drought.[56]

The Greeks danced in honor of their many gods: Apollo, Pan, Zeus, Dionysus, Artemis, et cetera. In the Greek religious mysteries "the sacrifice is more than a mere bribe; it is a friendly communion with the divinity; and the service is solemn and beautiful with hymn and dance." [57] The dance was introduced into the Roman church by the priests who were called the Salii, and they danced as a form of worship in their own rituals.[58]

Christianity encouraged dancing as a part of its early silent services held in the catacombs, private halls, and in the church.

"The first bishops, called Praesuls, led the sacred dance around the altar in the raised choir on feast days and Sundays. Each feast day had its appropriate hymn and dance, and there were dances before the tombs of the martyrs." [59]

"The hymn of Jesus, assigned to the second century, is nothing but a sacred dance." [60]

In the days of early Christianity—of Eusebius, Chrisostom, Origen—"the very idea of dancing had a sacred and mystic meaning." [61] The worship was a sacred drama, a divine pantomime.

"Mohamet imitating the Christian practice, instituted a sect of dancers, the Dervishes who twirl round and round with astonishing swiftness sometimes even till they fall in a swoon." [62]

"St. Basil recommended the practice of the dance on earth because it was the principal occupation of the angels in Heaven." [63]

Dante describes the souls in paradise as expressing their joy and exaltation through the medium of the dance and song.

St. Bonaventura (in *Dieta Salutis*) "described dancing as the occupation of the inmates of Heaven, and Christ as the leader of the dance." [64]

Although in 692 the council at Constantinople forbade the clergy to dance, its close affiliation with religious services was not entirely severed. In the thirteenth century its rôle in the church service was given a new impetus by the introduction of the miracle plays. Even though dancing in the church was forbidden by the Bishop of Cologne in 1617, this "prohibition of it did not affect (the use of) dignified and graceful movements. At the end of the Gloria Patri, the saint was invoked to pray for the worshippers and they promised to dance for him." [65]

Dancing continued in the English cathedrals until the fourteenth century; in France it continued in Paris, Limoges, and almost everywhere

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[56] Bible, I Kings, 18:26, 28.
[57] L. R. Farnell, *Encyc. Religion and Ethics*, Vol. VI, p. 395.
[58] G. Stanley Hall, *Educational Problems*, pp. 55–56.
[59] *Ibid.*, p. 56.
[60] Havelock Ellis, *The Dance of Life*, p. 40.
[61] *Ibid.*, pp. 40–41.
[62] Gaston Vuillier, *The History of Dancing*, pp. 49–50.
[63] *International Encyclopedia*, "Dancing," Vol. VI, p. 476.
[64] Havelock Ellis, *The Dance of Life*, p. 41.
[65] G. Stanley Hall, *Education Problems*, p. 56.

else until the seventeenth century, "and after the middle of the eighteenth century there were still traces of religious dancing in the cathedrals of Spain, Portugal, and Roussillon—especially in the Mozarabic mass of Toledo." [66] A dance of great antiquity, the Scisses, survives in the Seville Cathedral even today on the occasion of a few special religious festivals.[67]

In contrast to the rôle of the dance as a restrained, ceremonial form of worship we find that in times of great emotional strain and tension the early connection which occurred in the savage mind between the dance and magic vigorously reasserts itself.

"In the fourth century before our era, the city of Rome was desolated by a great plague which raged for three years, carrying off some of the highest dignitaries, and a great multitude of common folk. The historian who records the calamity informs us that when a banquet had been offered to the gods in vain, and neither human counsels nor divine help availed to mitigate the violence of the disease, it was resolved for the first time in Roman history to institute dramatical performances as an appropriate means of appeasing the wrath of celestial powers. Accordingly, actors were fetched from Etruria, who danced certain simple and decorous dances to the music of a flute." [68]

In the thirteenth century a religious sect known as the Brethren and Sisters of the Free Spirit believed that through the medium of whirling dances similar to the Shamanistic rites of the Siberians, or the Whirling Dervishes of Persia, they could be united with God. They wore fantastic apparel, spurned work of any sort, and traveled widely, holding a corrupt form of religious exercises.[69]

In 1259 and again in 1349 when the great plague, the "Black Death," was sweeping over Europe, various dancing manias sprang into existence as violent release mechanisms conditioned by the tremendous strain, distress, and superstitions of the times, as a means of combatting the spread of the dreaded disease.

"Processions of weeping, praying, self-scourging, and half-naked penitents appeared in the streets of all Christendom." [70]

In 1374 at Aix-la-Chapelle an epidemic of St. Vitus dance suddenly arose and quickly spread throughout Germany and Italy.[71] Sumner has said of it that:

"The Medieval dancing mania was more purely nervous. The demonism and demonology of the Middle Ages was a fertile source for such deductions, which went far to produce the witchcraft mania. The demonistic notions taught by the church took up, reduced to dogmatic form, and returned as such to the masses. Thus the notions of sorcery, heresy, and witchcraft were developed." [72]

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[66] Alexander Young, article on "Dance," *Encyclopedia Britannica*, Vol. VII, p. 15, 14th edition.

[67] Havelock Ellis, *The Dance of Life*, p. 42, note. Also *International Encyclopedia*, Vol. VI, p. 476.

[68] G. J. Frazer, *The Scapegoat*, p. 75, 1913.

[69] *Ibid.*, Vol. I, p. 408.

[70] William Sumner, *Folkways*, p. 213.

[71] *International Encyclopedia*, article on "Dancing," Vol. VI, p. 478.

[72] William Sumner, *Folkways*, p. 211.

During the French Revolution the populace frequently appeared in the streets vigorously dancing the Carmagnole.

Originating in New England and spreading westward from 1790 to approximately 1847 we find a religious sect known as the "Shakers" employing the dance as a part of their spiritualistic revivals.[73] As late as 1806 in New England, we find a religious sect known as the "Jumping Saints," and, more recently, we have the fervent religious meetings of the "Holy Rollers." These religious faiths are all based upon a common type of hypnotic treatment which is undoubtedly an attenuated form of the old ecstatic dance. The Puritanical influence, however, with its emphasis upon restraint in the expression of all types of emotion, has exerted a strong influence upon the general church service. Yet the Pilgrim Fathers themselves marched into church with a measured, swinging tread of two steps forward and one step backward, so that the rhythmic element even here, was not entirely excluded.

In our churches today, we find that the dance-motive per se, is not recognized: but there is the solemn dignity of the religious processional and recessional; the choir boys, the vested choir, and the priests, all keeping step to the music. Here we find singing, measured, and rhythmical movements all combined in a ceremonious offering to the Lord; and we further find the essence of the dance-motive in the posturings and genuflections which are still involved in the service.

St. Mark's-in-the-Bouwerie in New York City has for several years introduced dance rituals as a part of their religious ceremony. This created a tremendous sensation, for the average individual today thinks of the dance in terms of amusement only, and so renders himself incapable of seeing any further significance or value in it. Dr. Guthrie, the Rector of St. Mark's-in-the-Bouwerie, in an article printed in defense of this innovation, says:

> "The use of the body for religious expression is recognized by everyone in the attitude of kneeling for prayer, and in standing erect while singing hymns of praise. Its further development is the best protest we can make today against an erroneous asceticism due to Puritan traditions. Any restraint imposed upon a normal life of man's two-fold organism, may bring about anti-spiritual inversions, and perversions, to the injury of both body and soul alike. The whole of the life of man, in so far as it is susceptible of consecration to religion, must be consecrated through using the various avenues to approach the divine element which over-shadows the whole of human nature." [74]

Undoubtedly, the underlying motive for introducing these dance rituals is to permit the rhythmic impulse to bring the entire organism into a religious response in voicing the religious desires. There is no doubt that religion has suffered for centuries from a sterility due to the persistence of the intellectualistic motive that has ruled Western thought.

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[73] *Encyclopedia Britannica*, Vol. 24, p. 771, 11th edition.
[74] W. N. Guthrie, Preface to *The Eurythmic Ritual*.

As a result it has ceased to be an expression of the whole being of man. If all religious movements could unite in a common revolt against this barrenness of intellectualism, and if they undertook to re-introduce into religion these vital, non-intellectual factors, involving response from the entire organism, it is conceivable that modern religious consciousness would be revitalized thereby.

IV

THE DANCE AS A SOCIALIZING AGENCY

In the struggle for existence human beings most adequately develop their potential capacities by means of cooperative effort and efficient organization. A study of the history of developing social consciousness shows that some type of relationship between human beings, whether consciously or unconsciously directed, whether of a cooperative or an antagonistic nature, is all-pervasive.

The beginnings of society can be found in the spontaneous, uncalculated groupings of primitive man which were called into existence to satisfy a need. Man sought his fellow creatures in order to acquire a feeling of solidarity and of security; to maintain and to reproduce life. In the face of a precarious and unstable environment, it became necessary to unite or perish. Gradually control arose out of crises such as famine, drought, floods, or pestilences, and these early sporadic, human relationships came to be organized and developed into permanent forms. Since the earliest associations of man were concerned with his family, the institution known as Kinship was the first great socializing force. In the beginning the group was undifferentiated socially, all the members had equal rights, and common interests and needs fused them into a social whole. Each individual became a partner in an associated activity, sharing alike in the success or failure of the whole.

Economic progress, however, involves a type of organization in which the elements of specialization and subordination are stressed. The development of special skills, and the division of labor, at first conditioned by the aptitudes of the sexes, but later assiduously cultivated for the increase in efficiency and satisfaction which they afforded, paved the way for the transition from the Kinship period to the age of Authority. As commerce between communities increased, the opportunities for enlarged social contacts were multiplied. Power and leadership came to be vested in the individual who possessed great military prowess or skill, and the social fabric became complexly organized with various class distinctions. There were the ruling family, the warriors, the priests, the common laborers, and the slaves, each having specifically designated duties and privileges.

Gradually the qualities of freedom, initiative, spontaneity, and intelligent cooperation were emphasized, and the transition into the

stage of Citizenship was affected. Here, although the individual members of the state were enabled to make and to administer their own laws, the increased freedom of the members did not diminish the power and far-reaching influence of the social organization as a unified structure. Society thus becomes an increasingly intricate organization, involving certain sacrifices from each individual, yet in return, bestowing upon each member certain rights and privileges.

As the first social aggregations resulted from the desire to satisfy common organic needs, the sentiment of group loyalty to the larger whole was one of the first molding influences in the evolution of society. As each individual had little initiative or personal life apart from his group, conduct came to be regulated by certain folkways, or habitual modes of response which were sanctioned by the group. These folkways gradually became more clearly defined and developed into mores and customs.[75]

Working together, playing together, building or creating together, collectively invoking superhuman help, were from the beginning socializing modes of the cooperative agency. The entering of the ritualistic factor into work, play, and art invested them with something vaguely tending toward magic and religion, and the form of expression naturally merged into dance-behavior. Ceremonies arose out of the collective repetitions of effective utilitarian acts such as planting, harvesting, hunting, and war. Probably on account of the fact that ordered movements and gestures were the earliest forms of communication, the dance was an indispensable feature of these festivities. Either consciously or unconsciously, it was used as a means for reaffirming social unity, and we find that it occurs on all occasions of social importance. It appears to have been not only the channel through which the common interests of the tribe expressed themselves, but so completely did the dance sum up the life and tribal characteristics that it came to be the medium of intercourse between tribes. A tribe was known by its dances as they epitomized and identified the social customs, and the religion of a specific group. "When a man belonging to one branch of the great Bantu division of mankind met a member of another, said Livingstone, the question he asked was: 'What do you dance?' "[76]

A quotation from a recent magazine article clearly depicts the importance of the dance as a socializing instrument among African primitive tribes of today:

"Rhythm is the very heartbeat of Africa. Drums and the dance go together. They are woven into the warp and woof of African native life. They announce birth and marriage and death. They help drive away evil spirits. They celebrate hunting and

[75] The foregoing exposition of the method of socialization is based on the works of Sumner and Keller, *Science of Society;* Frederick Lumley, *Principles of Sociology;* William Wright, *Introduction to Ethics;* and Leonard Hobhouse, *Social Development.*

[76] Havelock Ellis, *The Dance of Life,* p. 35-36.

war. The planting of the crops and their harvesting begin and end with dancing to drumbeats. The coming of maturity of the girls, the coming of age of the boys and all other festivals are occasions for elaborate ceremonial dances." [77]

The human organism is so constituted that the feelings and emotions of an individual are greatly intensified and enhanced by the collective expression of a group of people under the influence of the same experiences. It is easy for a people to feel together, but it is difficult for them to think together. In thinking individual differences appear. Even though a number of people unite on a certain platform or creed it is the underlying feeling or emotion that is the true bond. The reason for this is that, as the level of intelligent development increases, human society becomes highly specialized, more separated into distinct parts, so that people tend to function in isolated sections rather than as an integrated whole. An urgent need is manifested for an activity in which the organism as a complete entity can harmoniously function.

The dance is particularly adapted as an effective instrument of the socializing process. With primitive peoples, since the dance emanated from their communal life, it was a type of behavior-response to the meaning, welfare, and in fact the very existence of their social whole. The chief concern of life at this period was to make a satisfying response to various urgent, practical needs, which in turn contributed to the group a bond of common interests and feelings. In the collective participation of large numbers involved in the same task, there is an indispensable need for some type of control system, a stimulating, regulatory force which will enhance the opportunities for cooperative effort. The primitive dance was the form which the group adopted to commemorate or to enhance the purposes of the tribe. The entire clan by participation in the dance was enabled actually to experience the feeling of solidarity which is so essential to the welfare of any organization.[78]

John Dewey in discussing the primitive era says:

"The young are instilled with the necessary disposition toward experience by participating in the ceremonies, by actually sharing in the pursuits of the older members of the tribe." [79]

Ideals and values are first incorporated and fostered not through the ideational element, but rather by an emphasis placed upon the naïve, sensuous appeal of the processional and festival.

"The dances of the hunting peoples are, as a rule, mass dances. Generally the men of the tribe, not rarely the members of several tribes, join in the exercises, and the whole assemblage then moves according to one law, in one time. All who have described the dances have referred again and again to this 'wonderful' unison of the movements. In the heat of the dance the several participants are fused together

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[77] Inglis Fletcher, "A Bootleg Dance Among the Ma-Nganja," *Asia* (September, 1930), 624.

[78] Editor's Note: A reference not mentioned, but very valuable in this connection is A. R. Brown, *The Andaman Islanders,* Chapter V.

[79] John Dewey, *Democracy and Education,* p. 9.

as into a single being, which is stirred and moved as by one feeling. During the dance they are in a condition of complete social unification, and the dancing group feels and acts like a single organism. The social significance of the primitive dance lies precisely in this effect of social unification. It brings and accustoms a number of men who, in their loose and precarious conditions of life are driven irregularly hither and thither by different individual needs and desires to act under one impulse, with one feeling, for one object. It introduces order and connection, at least occasionally, into the rambling, fluctuating life of the hunting tribes. It is, besides wars, perhaps the only factor that makes their solidarity vitally perceptible to the adherents of a primitive tribe, and it is at the same time one of the best preparations for war, for the gymnastic dances correspond in more than one respect to our military exercises. It would be hard to overestimate the importance of the primitive dance in the culture development of mankind. All higher civilization is conditioned upon the uniformly ordered cooperation of individual social elements, and primitive men are trained to this cooperation by the dance." [80]

That the primitive groups themselves are conscious of the socializing force of their dances is evidenced in the Australian Corroborries which are sometimes danced by two tribes desiring to eradicate any feelings of hostility existing between them.[81]

The converse of this dance of peace was the war dance, in which by means of pantomimic representation, the actual war situation was rehearsed. Hirn has called attention to the fact that the warlike tribes of the North American Indians, the Dahomans of West Africa, the Moors, and certain Polynesian tribes lay great stress upon uniformity and regularity in their military maneuvers. The warlike Maoris of New Zealand developed this element of precision to such a high degree of proficiency that in their war dance even the movements of the eyes and fingers are said to have been in unison. Hirn contrasts this emphasis upon the unity of cooperative effort in the dances of the martial tribes with the freedom in the dancing of the Hottentots who were said to be a peaceful people. They allowed every dancer to "act separately and for himself" [82] in their dances.

Although the primitive war dance was the means of educating the warriors in the necessary tactics, and the chief instrument in developing an *esprit de corps,* its outstanding function was undoubtedly to generate the sentiments of courage and daring which would enable the men zealously to carry out their proposed plan of action.

When groups of people are working together, rhythmic cooperation has the ability to synchronize the efforts of the many who are concerned with a common task, and to increase the pleasure and efficiency of the participants. Just how the rhythmic impulse works in stimulating social cooperation in occupational labors, is clearly shown in the following:

"How often have I not used their dancing songs in order to encourage and urge them on in their work. I have seen them, not once, but a thousand times lying on

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[80] Ernst Grosse, *The Beginnings of Art,* p. 228–29.
[81] *Ibid.,* p. 229.
[82] Yrjo Hirn, *The Origins of Art,* p. 262–63.

the ground with minds and bodies wearied by their labor; yet as soon as they heard me singing the Machielo-Machiele, which is one of their commonest and favourite dancing songs, they would yield to an irresistible impulse, and rise and join me with their voices. They would even begin to dance joyfully and contentedly, especially when they saw me singing and dancing among them like any other savage. After a few minutes of dancing I would seize the opportunity to cry out to them in a merry voice, Mingo! Mingo! a word meaning breast, which is also used in the same way as our word courage. After such an exhortation they would gradually set to work again. And they would begin afresh with such good-will and eagerness, that it seemed as if the dance of Machielo had communicated to them new courage and new vigour." [83]

The motives underlying this rhythmic organization of occupational activities was undoubtedly both utilitarian and hedonic. The "rhythmic swing" of the regulated movements resulted in an increased efficiency, an economy of effort, in a heightening of the emotions, and in an accompanying sensation of pleasure. This type of occupational enhancement has persisted through the various stages of culture. During the Middle Ages "with the formation of the guilds, each trade adopted its characteristic dance,"[84] which served as a medium for binding its members more firmly into a harmonious, social relationship. Other examples of this prevailing tendency are to be found in the various work canticles, sailors' chanties, or darkies' songs which arose spontaneously while groups were working.

"To many, work songs to secure concerted action in lifting, pulling, stepping, the use of flail, lever, saw, ax, hammer, hoe, loom, etc., show that arsis and thesis represent flexion and extension, that accent originated in the acme of muscular stress, as well as how rhythm eases work and makes it social." [85]

Wundt has also pointed out the fact that it is the dance which "brings men and women together and transforms labor into a cult act." [86] This concerted action regulated and controlled by rhythmic sequence can be designated as an elementary form of dance-behavior.

Although Crawley makes the statement that "the use of the dance as a social pastime is comparatively modern," [87] a few instances occur in the Bible which seem to imply its use as a form of popular diversion among the Hebrews:

"If the daughters of Shiloh come out to dance in the dances." [88]

" . . . behold they were spread abroad upon all the earth, eating and drinking, and dancing, because of all the great spoil that they had taken." [89]

"We have piped unto you, and ye have not danced." [90]

Perhaps, because the play element has been so effervescent, its con-

[83] Signor Salvado, *Voyage en Australie*, p. 182–83. Quoted in Yrjo Hirn, *Origins of Art*, p. 253–54.

[84] *International Encyclopedia*, article on "Dancing," Vol. VI, p. 476. Also Daniel Gregory Mason, *The Dance*, p. 129.

[85] G. Stanley Hall, *Adolescence*, Vol. I, p. 212.

[86] Wilhelm Wundt, *Folk Psychology*, pp. 249 and 268.

[87] Alfred Crawley, "Processions and Dancing," in *Encyclopedia of Religion and Ethics*, Vol. X, 362.

[88] Bible, Judges, 21:21.

[89] Bible, I Samuel, 30:16.

[90] Bible, Matthew, 11:17.

tribution and importance have not been emphasized during the earlier stages of culture. It seems probable, however, that a form of the dance whose object was purely the sheer, sensuous delight to be derived from abandoned, rhythmic movement, to some extent, must have been in existence throughout every stage of culture.

During the Middle Ages the use of the dance as a pleasurable form of recreation was widespread. The "religious pantomimes developed into popular diversions for the middle classes," [91] while the medieval nobility introduced dancing into their castles as a form of amusement in which they too participated. According to Vuillier,[92] during the thirteenth century, men and women both joined in the amusement. A Gallic proverb states that "after good cheer comes dancing." [93] Sumner has pointed out that even though "from the early Middle Ages the ecclesiastical authorities disapproved of dancing, the people were very fond of it, and never gave it up." [94] That Chaucer felt it was a popular form of social intercourse is evidenced in the Franklin's Tale:

> "At after dyner gonne they to daunce,
> And synge also, save Dorigen alone." [95]

In England during the reign of Henry VIII merrie England was noted for its flourishing dance forms. The king is said to have composed both music and dances.[96] In the reign of Queen Elizabeth dancing was encouraged as a form of popular diversion; in fact, it has been rumored that during this period coveted offices were sometimes secured by the statesmen who could demonstrate their skill in the ballroom as well as in the affairs of state.[97]

The dance as a form of amusement has filled an emergency need as an escape-mechanism when emotions are at a high state of tension. In France during the eighteenth century:

> "Immediately after the Terror, 1800 dance halls were opened in Paris, to furnish seven nights a week, relief for fever and frenzy." [98]

Vuillier also calls attention to the use of the dance as a form of relief from the terrific strain of the French Revolution. "Victim Balls" were frequently held, the admittance to which was limited to the members of the immediate family of a person who had been killed on the guillotine. This French historian of the dance clearly depicts the fervor with which these distracted souls sought some alleviation of their misery.

> "Moreover, dancing is universal; they dance at the Carmelites, between the massacres; they dance at the Jesuit's Seminary; at the convent of the Carmelites

[91] Daniel Gregory Mason, *The Dance*, p. 81.
[92] Gaston Vuillier, *A History of Dancing*, p. 61.
[93] *Ibid.*, p. 611.
[94] William Sumner, *Folkways*, p. 599.
[95] Chaucer, *Canterbury Tales*, "Franklin's Tale," 1:918–19.
[96] Gaston Vuillier, *A History of Dancing*, p. 383.
[97] *Ibid.*, p. 384.
[98] Troy and Margaret Kinney, *The Dance*, p. 109.

du Marais; at the Seminary of Saint-Sulpice; at the Filles de Sainte-Marie; they dance in three ruined churches of my section, and upon the stones of all the tombs which have not been destroyed . . . There are balls for all classes. Dancing, perhaps, is a means toward forgetfulness." [99]

Dancing as a modern form of entertainment has undoubtedly grown out of the ancient custom of using the dance as a tribute of respect, or a recognition of prestige. Since primitive peoples used the religious dance to show honor to the supernatural powers, when they wished to pay homage to a noted human being, it was a simple and natural transition to use the dance to express their veneration. Gradually the element of hospitality was combined with the imputation of distinction to the recipient. Homer, in his *Odyssey,* indicates this use of the dance when the king, Alcinous, called upon the Phoenician dancers to display their skill before Odysseus.[100] The Bible contains several instances in which the dancers are endeavoring to show honor to the Lord or to some important personage:

"But the children of Israel went on dry land in the midst of the sea. And Miriam the prophetess, the sister of Aaron, took a timbrel in her hand; and all the women went after her with timbrels and with dances." [101]

"And David danced before the Lord with all his might." [102]

"And Jephthah came to Mizpeh unto his house, and, behold, his daughter came out to meet him with timbrels and with dances." [103]

Undoubtedly, at the time Salome danced before Herod, the prestige of the dance as a form of respect and honor was being replaced by the sensuous desire to please one's spectators.

"But when Herod's birthday was kept, the daughter of Herodias danced before them, and pleased Herod." [104]

"But when the daughter of the said Herodias came in and danced, and pleased Herod and them that sat with him, the king said unto the damsel, 'Ask of me whatsoever thou wilt, and I will give it thee.'" [105]

In Egypt and Greece the guests at the elaborate banquets were entertained with dances performed by a special caste. Since the Romans were not particularly creative in their arts, they preferred to have professionals dance for them rather than to participate themselves. As their power and love of luxury increased they placed the emphasis upon a lascivious type of entertainment, which had a distinctly demoralizing effect upon both spectators and performers. The harem dancers of Turkey and Arabia, the Geisha girls of Japan, and the Nautch girls of India, all performed their dances with the specific purpose of pleasing their spectators. The dance, since it is an expression of the emotional nature, is a revealing

[99] Gaston Vuillier, *A History of Dancing,* p. 197.
[100] Homer, *Odyssey,* Chapter VIII, p. 116.
[101] Bible, Exodus, 15:19–20.
[102] Bible, II Samuel, 6:14.
[103] Bible, Judges, 11:34.
[104] Bible, Matthew, 14:6.
[105] Bible, Mark, 6:22.

index to the true nature of a people. In Greece, in Rome, in the eastern harems, et cetera, its use solely as a form of entertainment, performed by a professional caste, has been indicative of a decadence in the ideals and culture of the time.

The spontaneous, communal expression of collectively felt aspirations and ideals, is to be found in folk dancing. This type of dance is a part of the national heritage of a people, and is a means of expressing the ancestral and racial traits. G. Stanley Hall has referred to it as an "expression of the soul of a people," [106] as an integrating force which harmonizes the individual with his race. Because these folk dances have sprung up unconsciously in answer to a deep-seated organic need, Elizabeth Burchenal, an authority on this type of dance, has designated them as the "wild flowers of dancing." They are the simple, direct, yet energetic expression of rhythm, collectively enjoyed and participated in, by groups of hard working people. The distinguishing features of the folk dances of different countries are traceable to the mode of life, climatic and political conditions, as well as to the geographical location, and to the interests and ideals of a people. For instance, we find in the Spanish Fandango a dynamic, impassioned expression far different from the more restrained feelings which are embodied in the Morris dances of England. There is an element of vigor in both, yet the Spanish romantic aspect is strongly contrasted with the sturdy virility and lack of fire in the Anglo-Saxon folk dance. The contagious, rhythmic element and tricky steps of the Irish jig are indicative of the Irish wit. The vivacity of the Italian Tarantella is contrasted with the sudden abrupt changes from slow to fast, intense movements in the Hungarian Czardas. The Russian folk dances are outstanding for their inherent vigor and energy.

The prevalence of this so-called social or ballroom dancing of today is due to its deep-seated ontogenetic and phylogenetic roots. In its present mould it is a somewhat decadent form of this persistent and pervasive desire of the human organism to find a satisfying, overt, rhythmic expression for the feelings, thoughts, and emotions.

These facts all point to the use of the dance throughout its history as a great socializing force. At various stages of culture different aspects of the dance have been dominant; at times its close affiliation with work has been emphasized; at others its connection with religion, with love, or with art; yet, as Crawley has pointed out, at all times throughout its evolution it has given an intimate disclosure as to the nature of the social evolution of both society and the individual.[107]

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[106] G. Stanley Hall, *Educational Problems*, p. 59.

[107] A. E. Crawley, article on "Processions and Dances," *Encyclopedia of Religion and Ethics*, Volume X, p. 362.

V

THE DANCE AND THE SEX LIFE

The native endowment of the human organism consists of a set of prepotent reflexes, popularly known as instincts, which are the root-sources of human behavior as well as the controlling influences in the formation of habits throughout the individual's life. The majority of these reflexes are ready to function at birth, or soon after; however, the functioning of the sex-reflex is deferred until the age of puberty when the organic structures undergo certain changes. As the organism develops, these reflexes are modified constantly. This conditioning can be discerned in an enlargement of the range and complexity of the stimuli which call forth the response, as well as in the gradual refinement and specialization in the actual response itself. The result of this progressive modification is the acquired system of habits and dispositions of the developing organism.[108]

As the two sexes reach the age of adolescence there is a rapid maturation of the organic structures which are characteristic of puberty; this birth of the reproductive life is the underlying essence of the distinctive and phenomenal changes of this period. Various hormones or glandular secretions stimulate the growth of the secondary sexual characteristics, and also exert a controlling influence over the alterations in the height, weight, and strength of the individual. Sociologically, the individual emerges into an enlarged world, one in which there is a new interest in the duties and obligations of belonging to a larger social whole. Psychologically, a concern is awakened in regard to one's personal appearance; the opposite sex becomes more interesting; and the courting impulse manifests itself. As the new physiological forces and powers suddenly well up within one, there is an accompanying feeling of emotional instability. Oftentimes there is a sudden, keen interest in nature, religion, or art. Sensations of distress, despondency, and anxiety are frequent, yet the overwhelming sense of incompleteness tends to manifest itself in the striving toward an ideal. Out of these new and bewildering experiences, many of which are tempestuous, emerges a new self-hood, a reawakening of life to a fresh, self-conscious appreciation of things.[109]

One of the persistent problems from the earliest days of reflective thought has been what rôle the emotions are to play in a well-regulated life. The behavior of primitive man must have been largely an unrestrained, emotional response to an exciting stimulus. Gradually taboos, mores, and customs began to regulate his life, but we find that even then,

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[108] The basis for this discussion is to be found in: T. G. Duvall, *The Intelligence Function*, and in Floyd Allport, *Social Psychology*, Chapter 3.

[109] The basis for this discussion is to be found in: Floyd Allport, *Social Psychology*, Chapter 3; G. Stanley Hall, *Adolescence*, Vol. II; and in Edwin D. Starbuck, *The Psychology of Religion*.

at the time of festivals, there is often a reversion from the moral status created by the later mores, to the ancient "natural" ways.[110] Aristippus represented a cult of pleasure which found few defenders among the Greek thinkers. The keynote for Greek philosophy was struck by the Pythagorean brotherhood when they set up reason as the rightful sovereign of life. But it was Plato[111] who gave the classic expression of Greek thought, by clearly separating the appetites and instincts. He emphasized the fact that the appetites were the lower or baser parts of our natures, which should be kept subject to the law of reason. In the interpretation of the teachings of Jesus by the Apostle Paul, this dominant motive of Greek philosophy was stressed. The warfare on the impulses and appetites of the body was considered inconsistent with a godly life.

"Walk in the Spirit, and ye shall not fulfill the lust of the flesh."[112]

"For the flesh lusteth against the Spirit, and the Spirit against the flesh; and these are contrary the one to the other."[113]

If one were to read the words of Jesus carefully, a question could arise as to Paul's authority for emphasizing the baseness of the bodily appetites, per se. Yet history reveals that Paul's view of the matter was to become the dominant view of the Christian Church for many centuries. Before the Apostle John died, influences from Persian dualism began to trouble the early Christians. The Manicheans, a numerous sect whose influence was far reaching in the third century, supported the belief that the human body was essentially evil and the source of all moral perversion. The Neo-Platonists brought this thought to a classical formulation under the leadership of Plotinus in the fourth century.

"To purify the Soul signifies 'to detach it from the body and to elevate it to the spiritual world.' The Soul is to strip off all its own lower nature, as well as to cleanse itself from external stains; what remains when this is done will be 'the image of Spirit.'"[114]

"The reason for chastity, in the Platonists, is not that we ought to be ashamed of the natural instincts, but that sensual indulgence impedes the ascent of the Soul from the material to the spiritual world, riveting the chains which bind it to Matter, and preventing it from seeing and contemplating super-sensuous beauty."[115]

But it was Augustine, a Neo-Platonic philosopher before his conversion, who wrote this thesis into Christian theology, thereby fastening it upon the consciousness of the western world. As Christianity developed, the rejection of worldly pleasures became not merely an end in itself as the Stoics had formerly regarded it, but a means for realizing a fuller life in the infinite world. Man was interested in stamping out

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110 William Sumner, *Folkways*, p. 561–562.
111 Frank Thilly, *A History of Philosophy*, p. 69–70.
112 Bible, Galatians, 5:16.
113 *Ibid.*, 5:17.
114 William Inge, *The Philosophy of Plotinus*, Vol. II, p. 165.
115 *Ibid.*, p. 168.

his lower nature so that God might enter and enrich his life. The emphasis was placed upon "otherworldliness," and the "withdrawal of the soul from this world." The Greek and Persian philosophy and Medieval theology, however, were not alone in their declaration of war on the sensuous elements in life. Spinoza, the modern Stoic, seeking the root cause of all humanity's perplexities and troubles, believed that he had located that cause in our bondage to the emotions and passions which spring from our bodily nature.

Repression is undoubtedly the oldest and most widespread practice by those who wish to be free from emotional disturbances. As civilization has advanced, conventions have inhibited the free and spontaneous expression of the emotional nature, and have stressed the necessity for self-control. Yet, the repression of this dynamic factor in life often leads to physical and mental disorders. When for instance, the sex impulse is diverted from its normal expression, "sublimated," or given other social objectives, it cannot avoid giving to the personality a distinguishing mark. The ascetic way of escape has been practiced in every land and in every age, yet it is reserved for the consecrated few who are seized with the burning zeal to make a holy warfare on the world, the flesh, and the devil. The common instruments which they believe will liberate the soul are flagellation, self-crucifixion, and mortification of the flesh. The story of how the soul is liberated from the torments of unfulfilled desire by such methods is told by the artist Carpaccio in his series of legendary paintings dealing with the life of the early church father, St. Jerome.

The transcendent mode of escape has been adopted by the idealists of all schools and ages. Plato, who pointed out this path, was followed by Epictetus, Seneca, Marcus Aurelius, and the modern Stoic, Spinoza, all of whom were supporters of this view of life. Even in the New Testament, there are many passages which express the same thought. The defect of this method of escape is that it leads to an over-emphasis upon other-worldliness, to such a concentration of attention upon the divine world that the real objects of human life are apt to be pushed into an insignificant rôle. As Spinoza has pointed out, it would no doubt contribute a certain serenity and freedom, yet it would reduce life in the here and now to a very meager outline.

The third way of escape is the middle path between the two extremes, the authorship of which the history of philosophy credits to Aristotle. According to this eminent thinker the emotions, appetites, or desires are morally indifferent, per se; in themselves they are neither good nor bad. It is their use which determines their ethical status. If they are used to further the well-being of life they are good; but if they hinder or interfere with the true ends of life they are bad. Aristotle includes the sex life in this category, as he feels that under the proper guidance it too has

the capacity to contribute to the moral self-realization of both the individual and society. That Jesus held a similar attitude of mind seems to be indicated by his presence and participation at the marriage in Cana of Galilee, and his point of view concerning the plight of the Magdalene.

As we shall see, these various views regarding the emotional nature have a direct influence upon dance-behavior. The dance, making possible the proximity and contact of the sexes, becomes not only a release-mechanism for pent-up sex-emotion, but, under proper auspices, a worthy instrument in love-making. An investigation into the customs and practices of semi-civilized peoples indicates a widespread recognition of this fact. Crawley[116] has emphasized the use of the dance in New Guinea as a means for the men to display their physical prowess before the women of the tribe. The dance became a powerful factor in sexual selection, for the best dancers were the ones who were most successful in winning the affection of the women. Ellis in a quotation from Haddon emphasizes the same point:

> "It was during the secular dance, or Kap, that the girls usually lost their hearts to the young men. A young man who was a good dancer would find favor in the sight of the girls. This can be readily understood by anyone who has seen the active, skilful, and fatiguing dances of these people. A young man who could acquit himself well in these dances must be possessed of no mean strength and agility, qualities which everywhere appeal to the opposite sex. Further, he was decorated, according to local custom, with all that would render him more imposing in the eyes of the spectators. As the former chief of Mabuiag put it, 'In England if a man has plenty of money, women want to marry him; so here, if a man dances well they too want him.' In olden days the war-dance, which was performed after a successful foray, would be the most powerful excitement to a marriageable girl, especially if a young man had distinguished himself sufficiently to bring home the head of someone he had killed." [117]
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> In the Faroe Islands "the dance is simply a permitted and discreet method by which the young men may court the young girls. The islander enters the circle and places himself beside the girl to whom he desires to show his affection; if he meets with her approval she stays and continues to dance at his side; if not, she leaves the circle and appears later at another spot." [118]

Even when civilization advances we still find that the dance is closely connected with love and courtship. Smith and Young have pointed out its rôle in the French courts, as a propaedeutic for the sedulously cultivated etiquette demanded of the lords and ladies of that period.[119] The delight of primitive peoples in the pantomimic representations of the elements of love, namely reticence, jealousy, allurement, pursuit, and surrender still linger in the folk dances of various peoples. The Swedish Daldans depicts the "taming of womankind" while the Vingakersdans

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[116] A. E. Crawley, article in *Encyclopedia of Religion and Ethics*, Vol. X, p. 359.

[117] Haddon, *Reports, Anthropological Expedition to Torres Straits*, Vol. 5, p. 222. Quoted in Havelock Ellis, *Studies in the Psychology of Sex*, Vol. 3, p. 43.

[118] Raymond Pilet, "Rappart sur une Mission en Islande et aux Iles Feroe." Quoted in Havelock Ellis, *Studies in the Psychology of Sex*, Vol. 3, p. 51.

[119] Smith and Young, article in *Encyclopedia Britannica*, Vol. 7, p. 797, 13th edition.

of the same country gives a pantomimic interpretation "of the competition of two women for the same man."[120] In Bavaria the Schuhplatteltanz opens with a staid promenade which soon develops into a prolonged series of vigorous whirls executed by the woman turning under her partner's hand. Gradually the spinning subsides and

"Having caught his partner after her spin, waltzed again with her for a few bars, and lifted her up at arm's length in sheer playfulness, the man joins arms with her in such a fashion as to form almost a duplicate of the 'mirror' figure of the minuet. The courtliness of the cavalier in the minuet is matched by adroitness on the part of the Schuhplatteltanzes; he contrives to draw his partner's head nearer and nearer to his, as they walk around in a lessening circle. Finally when the circle of the promenade can become no smaller, and the faces have come close to the imaginary mirror framed by the arms, he suddenly but daintily kisses her lips."[120]

According to Rousseau:

"Dancing is an admirable preliminary to courtship, and the best way for young people to reveal themselves to each other, in their grace and decorum, their qualities and defects, while its publicity is its safeguard."[121]

A study into the customs of primitive and semi-civilized peoples who are unshackled by the inhibitions of a highly developed moral culture reveals that they are accustomed to use the dance as a prelude to sex orgy, and as a means for heightening sex-desire. But even here, on the plane of primitive peoples, these erotic dances were intended as a recognition of the mystery of the origin of life and were given in honor of the procreative principle.

Among Semitic races local deities, designated as Baal, were regarded as the controllers of the fertility of the soil or flocks; among the Phoenicians, Ashtaroth was the goddess of the productivity of life; among the Greeks, Dionysus was originally a god of vegetation; and among the Romans the goddess of "bloom and beauty" was Venus. The ceremonies in honor of these deities took the form of obscene dances and orgies, the object of which was an appeal to these generative forces of nature to demonstrate their beneficent productiveness. The provocative nature of the erotic dance and its close association with the sexual impulse is clearly brought out in one of Havelock Ellis' quotations regarding Australian primitive groups in a dance of the Dieyerie tribe:

" 'This dance men and women only take part in, in regular form and position, keeping splendid time to the rattle of the beat of two boomerangs; some of the women keep time by clapping their hands between their thighs; promiscuous sexual intercourse follows after the dance; jealousy is forbidden.' Again, at the Mobierrie, or rat-harvest, 'many weeks' preparation before the dance comes off; no quarreling is allowed; promiscuous sexual intercourse during the ceremony.' The fact that jealousy is forbidden at these festivals clearly indicates that sexual intercourse is a recognized and probably essential element in the ceremonies."[122]

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120 Margaret and Troy Kinney, *The Dance*, p. 182.

121 Havelock Ellis, *Studies in the Psychology of Sex*, Vol. 3, p. 56. Quoted from J. J. Rousseau, *Nouvelle Héloise*, Book IV, Letter 10.

122 Havelock Ellis, *Studies in the Psychology of Sex*, Vol. 3, p. 41.

Since the dominating leadership of western civilization was vested in the church with its emphasis upon the rational and spiritual rather than the material aspects of life, the sex-impulse was subordinated, and a sharp demarcation was drawn between decency and decorum on the one hand, and on the other, the suggestive and lewd.

Naturally in classical times, even among the more highly cultured races, there was little sex reticence as we understand it. Among the Greeks the Heterae were groups of professional women dancers whose performances were not considered vulgar by them but were "suggestively sensuous." Sappho and also Aspasia, the wife of Pericles, were said to have belonged to this class.[123] The Kordax was an ancient comedy dance which at first was noted for its refreshing humor, satire, and caricature of famous figures.[124] Later it became associated with sensuality and Bacchic excesses. As Greek culture declined, the dances connected with the ancient mysteries lost their ethereal qualities and emphasized the sensual element to the exclusion of all else.

Among the Romans, whose material philosophy of life stifled their ability to appreciate the spiritual qualities in Greek art, the dance degenerated into a suggestive, provocative pantomime of obscenity,[125] and a pretext for all types of license. That this type of dance was indicative of a belated moral sense is manifested in Cicero's remark that "no decent person would dance either in public or in private."

In more recent times, the French can-can, and the tango of Spain and of South America are instances of the use of the dance with aphrodisical intent and with the full consciousness of its debasing character. Yet even these dances which have been regarded as modern adaptations of the extravagances indulged in during the ancient Bacchic and Dionysian festivities can be modified and the objectionable features are eliminated when they are danced by people possessing a high type of cultural development.

> "The gestures of the Tango, as danced among the Haytian women, even in the higher circles of Port-au-Prince, is never objectionable, as is the case with the Spanish creoles; from which is to be seen that the dance, consciously or unconsciously, has a different purpose among these people. All the more undisguised is the crude sensuality among the lower classes of the Haytian population."[126]

The sex drive is probably the most potent and persistent of our mental drives, and at the same time most pervasive and capable of sublimation. Sex emotion of every variety tends to emerge naturally in appropriate expressive movements in fulfillment of desire, and in the process, the dance has been found a peculiarly flexible instrument.

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[123] Daniel Mason, *The Dance*, p. 70.
[124] William Sumner, *Folkways*, p. 575.
[125] Margaret and Troy Kinney, *The Dance*, p. 24.
[126] Albert Friedenthal, *Drusik, Tanz and Diehtung bin den Creolen Amirkos.* Quoted by Krehbiel, in *Afro-American Folk Songs*, p. 94.

VI

THE DANCE AS AN ART

Heretofore our attention has been largely centered upon the dance as a spontaneous and natural form of expression arising in response to certain primal urges and needs of the developing human organism. The dance, like other activities in their crude beginnings, came into being as an overflow of primitive impulses in the form of random activity. As we have already seen, it was immediately used as an instrument for the development of certain economic, social, and religious ends; yet this early association of the dance with the necessities of life does not encompass all of its functional possibilities. Even in the beginning there came the unique impulse to dance for no other reason than its own sake. This desire, as we shall see, was to overshadow the importance of all other motives. Engaging the creative powers of man, it began to modify the dance and gradually transformed it into more cultivated modes of expression. The entire realm of activity was re-evaluated and raised to a higher level.

As a result of this development the dance, which had formerly been chiefly concerned with utilitarian motives, now acquired an element of spirituality. It became a motor expression of the longings and aspirations of man in his search for deeper and more significant experiences. Man has in his nature a tendency toward spiritual pioneering. Almost from the beginning of time he has felt the necessity to realize his dreams and ideals in some external form. The dance has been one of the earliest and most prevalent mediums for objectifying these visions of mankind.

It is at this point that a new problem emerges. Is there some quality inherent in the act of dancing itself which accounts for this transition from savage behavior to a more cultured form? Such a transformation is a curious phenomenon. A modern individual, witnessing a savage dance for the first time, might be utterly surprised if he were told that the crude, uncoordinated, and often obscene movements which he observes are the direct ancestors of the modern choreography. And yet the germ roots are there, from which finally evolve the work of a Kreutzberg or a Martha Graham, expressive of the culture and idealism of a complex and mature civilization. What enables the dance not only to express the early needs of the organism but to symbolize as well the higher ranges of meaning and value which are created by the mind? The answer is to be found in the essential nature of the dance as an art.

Art, as an activity of mankind, is different from most other human enterprises in that it is often entered into and enjoyed for its own sake. In fact, this tends to become its most important characteristic. The dance, called into being at times by urgent personal and social needs which it subserved, was also engaged in for the immediate pleasure and

gratification it afforded. The war dance which had been a necessary stimulant to the warriors and an effective means of insuring a victory, or the ceremonies performed when a bountiful food supply was desired, became ends in themselves. Men discovered that even without the stimulus of actual war or threatening famine, the vigorous rhythmic and patterned movements gave to the participant a keen sense of enjoyment. Activity of this sort is a kind of play in which the imagination finds supreme and sufficient satisfaction.

But art is more than play. In play, the imagination is released from its bondage to the practical and the purposive, but it is still blind. It awakens to art only when, in playing, it suddenly becomes aware of the enchanting qualities of sensory experience which free activity invokes and begins to cultivate and to enhance the sensuous element for its own pleasurableness. The tingling delight of movement, the exquisite sensations of color, sound, texture, and warmth are embedded in play; they constitute its vividness. But in art they come to the surface and are acknowledged. They become the immediate ends of an artful manipulation which is more than play and which leads to the dance as an art-form. These two features, the freedom of the dance from continuous service of prosaic life needs and its capacity to bring forth an intrinsic appreciation of the sensuous, constitute two essential characteristics of art.

Another important element lies in the fact that art like play is a form of self-expression. That is, the activity is motivated from within. Energy flows into spontaneous action, called forth and guided only by the natural laws of the organism itself. Yet, unless art is more than self-expression it would be impossible to distinguish it from any other form of spontaneous activity. A group of boys suddenly released from a long session in school burst out of the doors, toss their caps in the air, turn hand-springs through the school yard, and shout as they dash along. Here is a form of contagious self-expression, manifesting a distinct sense of value and meaning, yet it can scarcely be called art. The meaning of the experience has not risen above the subjective or personal aspect, nor has the imagination made any creative attempt to embody the values in a deliberatively expressive pattern. When the activity ceases no permanent form remains which could be interpreted as valuable either in itself or as a symbol of feeling.

Art, on the contrary, rests upon self-expression only to transcend it. It takes that which is momentary and narrow, and makes it over into something of large and permanent meaning. It has the capacity to incorporate into a thing of color or line or movement the totality of meaning which that thing (the art-object, we call it) can have for the artist and the group to which he speaks. Its supreme value, then, lies in the emotional realization of an embodied and communicated meaning.

It is for this reason that art has been defined by Philo Buck as "the perception and communication of values in experience"[127] and that Tolstoy has said that when feelings are so sincerely expressed that others become infected with them and share in the experience of the creator, art comes into being.[128] The dance, one of the first forms of art, is so constituted that it can interpret and communicate these deeply rooted values of life in an intensified and spiritualized form.

These then are the distinctive features of art as displayed in all its manifestations. In the case of the dance, as in that of other arts, a long process of development had to take place before it emerged in its entirety and became a full-fledged art. The history is obscure and many steps must be altogether lost to the historian. But certain phases of the process can be discerned, each of which carried the dance an important way from an undirected outflow of organic exuberance to a mature art.

The first phase takes us back to the beginnings of muscular activity. Movement in its crude origin is composed of simple, haphazard, and experimental activity. The organism (for at this stage it can scarcely be termed an individual) is concerned with impulses to move, to explore, to overcome obstacles. The first dance probably sprang into being as the muscular accompaniment of the outburst of a strong emotional state. The organism has its own laws of activity, and they operate most naturally when a strong emotional state disrupts the higher forms of control and places the lower centers in charge. On account of the balanced and symmetrical arrangement of the human form, the most violent behavior tends to fall into a definite pattern—the more so because it is violent. The steady approach of the attacking man (or animal) wild with rage and intent upon his prey, is effected by a balanced alternation in movement of the two sides of the body, in which a swinging yet stable equilibrium is clearly apparent. The periodic repetition of movement is itself rhythmic. Here, then, in embryo, are the art-patterns of the dance in full operation: balance, symmetry, repetition, and rhythm.[129]

The fundamental origin of dance movements in emotional activity is most clearly seen in connection with rhythm. In fact, rhythm may be said to govern all behavior during intense emotional excitement. A worried individual paces back and forth across a narrow room, using a

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[127] Philo Buck, *Literary Criticism*, p. 406.

[128] Aylmer Maude, *Tolstoy on Art*, p. 173.

[129] So closely are these specific types of activity bound up with emotional expression itself, it is often impossible to say whether the activity stimulates the emotion, or the emotion calls forth the activity. The nervous mechanism of the body is so arranged that there is an intimate connection between the functioning of the glands, nerves, and muscles of the body. When a swift run is taken with the face uplifted so that the wind can be felt rushing against it, an accompanying sensation of exhilaration and joy results. Walking with the body bent over, with the fists clenched and the feet taking long, heavy steps, if continued for an appreciable length of time will contribute a feeling of depression, of weight, or even of sadness. This point of view is given a psychological formulation in the James-Lange theory of the emotions.

measured and monotonous tread. An angry person repeatedly twitches the facial muscles or periodically clenches and unclenches the fists. A person in grief rocks to and fro and beats his head rhythmically against the wall. Even among animals and birds the excitement of sexual approach and congress takes rhythmic form.

"In Northern America large numbers of a grouse, the Tetrao phasiarellas, meet every morning during the breeding season on a selected level spot, and here they run round and round in a circle about five or twenty feet in diameter, so that the ground is worn quite bare, like a fairy ring. In these partridge dances as they are called by the hunters the birds assume the strangest attitudes, and run round, some to the left and some to the right." [130]

In every case, the emotional state is expressed in terms of momentary expenditures of energy alternating with momentary periods of relaxation. The tempo of the release and relaxation of energy corresponds to the intensity of the emotion. The repetition of the same series of movements evolves a definite rhythmic sequence. With the emotion centered upon a definite object and integrated around a single desire, there is natural unity in even the most incoherent leaps and gyrations. Thus regulated and controlled by the natural laws of rhythm, an emotional outburst can be incorporated bodily into a dance, and an elementary art-form has come into being.

At the same time the dance activity is slowly conditioned by algedonic discriminations. The organism tends to repeat the movement which brings about a pleasurable feeling, and to avoid the activity which results in pain or unpleasantness. This criterion, based upon agreeable and disagreeable sensations, forms the basis for the development of valuational attitudes, and for the objectification of values into things desired or avoided. Emotional activity at its height has meaning in terms of things wanted, fought for, and possessed (or mourned, if not possessed) and things unwanted, feared, and avoided. So the dance which incorporates emotional activity incorporates its meanings. To dance is to realize the worth of some value in a concrete and intimate way and to increase its worth as well, for the dance precedes and in a very real sense delays direct action while inciting it. It thus enhances values and elevates meanings, transcending the coarse algedonic responses which brought it forth. As new values are discovered and emphasized, they in turn find expression in the dance. Thus rhythmic movement develops into a plastic language capable of interpreting symbolically the outstanding events and the significant meanings of life.

In this connection, an interesting complication often occurs. The dance movements always prove to be enjoyable, though the meanings expressed may be deeply tragic and intensely painful. There are dances of sorrow in defeat and death as well as dances of happy anticipations

[130] Charles Darwin, *Descent of Man*, Vol. II, p. 65–67.

and glorious victories. Whenever a lack of harmony arises between the emotional element and the ensuing movement, the result is a syncopated, rather than a smoothly functioning, form of expression. For this reason, one of the outstanding characteristics of primitive rhythms and dances is this element of syncopation.

In the first phase of the dance, then, there develops out of the laws of free bodily activity under the stress of emotional excitement a form of art. The principles of balance, symmetry, repetition, rhythm, unity, and others, all of which are recognized as structural elements of art, grow out of the nature of the activity itself. The framework of the art-form is already there. As culture develops, attention will be focused upon the structure, upon unfolding, cultivating, and refining these vital and dynamic elements. Newer and higher values will be built upon this underlying structure. But even the most sophisticated and revolutionizing art will transcend this primitive structure only to exemplify it more clearly.

When the attention becomes focused upon the elaboration of the inherent art principles which manifest themselves in this first stage, the second level in the development of the dance as an art-form is reached. At this point certain factors tend to limit further growth. Among primitive peoples definite dance patterns were connected with the announcement of birth, death, or the coming to maturity of the boy or girl. War, love, famine, drought, the hunt—in fact all of the everyday occurrences—were celebrated in rhythmic form. But the primitive range of interests and activities was small. Before long the limit of the occasions calling forth dance-behavior was reached. The dances of a tribe or people became a part of the traditional heritage and were impressively transmitted from one generation to another, even though the needs which caused the activities to spring into existence may have long since disappeared. Custom and tradition were the external authorities which regulated and dictated behavior.

Since at this stage of development, both in the race and in the individual, few new interests and values are created, life energies are directed toward cultivating and consciously incorporating the structural principles into dance forms. The emphasis which has formerly been placed upon the values to be interpreted is transferred to the manner in which they are to be expressed. The original meaning is gradually lost sight of and an undue emphasis is placed upon the perfection of technique. The former spontaneity and spirit become involved in the intricacies of a highly complex form, and in the endeavor to conform to definitely prescribed rules and formulations.[131] An element of artificiality replaces the earlier qualities of sturdiness and sincerity. In contrast to the crude

[131] EDITOR'S NOTE.—An excellent discussion of this phase of art is found in Carr-Saunders, *The Population Problem,* page 463.

simplicity of the previous period, the dance at this stage consists of an infinite variety of patterns and movements. The ability to evaluate and to discard the non-essential features has not yet developed. As a consequence, the dance forms sometimes become so elaborate that they border on the baroque. The Highland Fling and the Scottish sword dances, as well as the minuet, the pavane, and even the ballet of the French court exemplify this stage in the evolution of the dance.

The valuable contribution of this phase of development lies in the fact that the liberation of the dance from the early utilitarian pursuits has been effected. But to counterbalance this is its loss of purpose and vitality. In the process of freeing itself from the practical utilities of life, the dance is no longer regarded as a serious pursuit. For many people it becomes, and unfortunately remains, merely a traditional pastime or a means of entertainment.

A spirit of revolt against the conventions, traditions, and rules of the folk-dance and the ballet paves the way for the third phase of the development cycle, the period of creative genius. The stimulus for this revolt is a new breath of life in individuals accompanied often by restless stirrings in society. One immediately thinks of the Italian Renaissance, which disturbed men with new life meanings and re-animated the art of painting on a new level, or of the French Revolution from which grew the Romantic movement in literature, painting, and finally the dance. A renewed creativity manifests itself with its attention focused upon meanings and values rather than upon the manner of expression. The previous desire for group formations which characterized the folk-dancing of the preceding period is here supplanted by a keen interest in an individualized type of interpretation. Various individuals are fired with the enthusiasm and intense desire to express their own personal equation of values, and so add to the totality of things. A courageous, self-assertive, creative spirit manifests itself in response to this impelling, inner necessity to express concretely one's own feelings, emotions, and thoughts.

The dance at this level of its evolution breaks away from formal, standardized forms. Freedom of expression is the keynote. Many unique and startling achievements are created; and since they are the outcome of individual and distinctly personal points of view they are as varied as the personalities from which they emanate. The quality of art which is created is conditioned by the depth and understanding of the emotional life, the maturity of the intellect, the whole-heartedness with which the response is made, and by the amount of specific technical skill which the individual possesses. The art principles which have been utilized in the first and second periods of this complete development are not painstakingly employed. In most cases they are not apparent at all; instead, the creator deliberately strives to transcend the confines of set,

regular forms, and allows only the dictates of his own nature to say what the principles are which shall govern his work. Even though a universally understood system of dance notation were to be used, all that could be captured and formally transcribed would be the outer shell of the activity. The real essence is a fleeting, ephemeral, and personal equation of values. In the history of the dance this phase of development is most clearly seen in the work of Isadora Duncan.

The outstanding characteristics of this period are the rejection of the previously accepted traditional forms and regulations, an interest in personal interpretation rather than in the mass group activities, a striving to find within one's own self more adequate principles by which to work, and an attempt to create new meanings and values.

The maturing of the ideals which thus come into existence leads the dance into the fourth and highest stage of development. Here aspirations are fulfilled and the great and enduring art forms are perfected. The dance at the same time regains the element of spontaneity which was the most prominent characteristic of the first phase. But it is a new and more subtle spontaneity, that which arises out of a long apprenticeship in creative art. It grows out of a process of reorganization and reconstruction by which an adequate style is gradually moulded into shape. Fundamental to this growth are newness of spiritual grasp, a deepening insight, and a more complete realization of the self. A controlled simplicity of expression emerges, for the non-essential elements are eliminated, and a certain directness of style is achieved. This directness, at first glance, may seem to resemble the simplicity of the primitive period; but a new quality of restraint is evidenced which presupposes an insight and understanding far in advance of primitive comprehension.

When the mind is able to create new meanings and values, and the body has acquired the ability and skill to interpret and to communicate these significant features of life to others so that they, too, are carried beyond the confines of their own personalities, the highest manifestation of the dance as an art comes into being. The enjoyment of the sensuous element is still present, but it is transcended and re-embodied in a detached, impersonal, and spiritual kind of appreciation. There is an emotional realization of an integrated and communicated significance. The dance in this level is not concerned with the mere display of technical skill or the revolt against outworn forms; instead, the technique becomes a medium for interpreting the deepened and enriched evaluations of life. The dancer is not trying to create a sensation or attract attention by a spectacular exhibition of the self, but is concerned rather with the desire to re-interpret to others what has been found to be significant in life.[132]

How quickly or how slowly each individual reaches this level of

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132 Here in America on the concert stage we find this form of the dance effectively and artistically interpreted by Martha Graham, Charles Weidman, and Doris Humphrey.

development depends upon the capacity to appreciate, the level of intelligence, the ability to invest the world with meanings and values, the mastery of the technique, and the ability to subordinate this technique to the ideas, feelings, or emotions to be expressed. For the dance to achieve its highest manifestation it is essential that it be developed through these stages of evolution with each individual. Only then will the essential richness, depth, vitality, and creative ability be adequately brought out.

These four stages of development have traced the evolution of the dance from the raw, crude movements of the savage to the refined and cultivated rhythmic expression of a high type of civilization. The transformation was effected through a continuous process of orientation, a progression from simple to complex rhythmic movements, and then to the development of a controlled, restrained simplicity. The dance as an art is an emanation from the vital life forces, both ontogenetically and phylogenetically, the result of a persistent process of emergent evolution. Since the dance as an art is interpretative of the ideals and aspirations of the civilization from which it arises, it is continually undergoing a re-birth.

CONCLUSION

Only in recent years has the mental life been construed from the point of view of organism, as an ongoing system of behavior responses to environmental stimuli. The psychological shift has been away from an intellectual to a functional or pragmatic emphasis, and has in consequence, opened up a new approach to many problems of human interest. As long as mind was conceived as a group of faculties, or as a mechanism of sensations or ideas, or as a stream of psychical processes whose nature was completely revealed in introspection, the door to the heart of many human interests was closed. For the mental life is not mechanistic; it is instead organic. It is a thing of growth whose character is the outcome of internal responses rather than accretions from without. It is a complex function which is neither inner nor outer, but is actually both, in one, all-inclusive, organic unity.

It has been the purpose of this thesis to approach the phenomena of the dance from this point of view, attempting to understand and interpret it as a mode of organic functioning. Conclusions have been reached as follows:

First, the dance, not only in its initial impulse but throughout its history, has been an effective type of motor-language through which the organism has expressed the meanings of the unanalyzed total experiences.

Second, on the level of higher appreciations, especially where art, worship, and social values are involved, the dance has been a flexible instrument in interpreting sentiments.

On these two conclusions it is reasonable to base the expectation of increased recognition of the dance as an important art-form in the development of human personality.

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The Determination of the Efficiency of Group Learning Under Different Incentive Conditions and Modes of Activity

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SOME experimental studies of the amount and rate of improvement in track and field events have already been reported.[1] These reports did not permit comparisons in improvement under varied conditions throughout a semester nor were records available to plot learning curves in the events involved.

It will be the purpose of this study, then, to note peculiarities in improvement made under a variety of conditions and to keep such records as will enable us to plot learning curves in several events.

EXPERIMENTAL GROUPS

The groups studied were organized in six track and field classes of the writer during the fall semester of 1931 as follows:

(1) Dash—practiced dash only, 17 cases.

(2) Dash—practiced dash only, three minutes of distance running at the end of each period, 11 cases.

(3) Low Hurdles—practiced low hurdles only, 10 cases.

(4) Low Hurdles—practiced low hurdles only, three minutes of distance running at the end of each period, 15 cases.

(5) Distance Group—practiced distance only, 23 cases.

(6) Broad Jump—practiced broad jump only, 5 cases. This group dwindled out so that there is little reason for giving it consideration.

(7) Shot Put—practiced 12 pound shot only, 16 cases.

(8) Shot Put—practiced 12 pound shot only, 12 cases; three minutes distance work at the end of each period.

(9) Discus—practiced discus only, 9 cases.

(10) Discus—practiced discus only, 20 cases; three minutes distance work at the end of each period.

At the start of the semester, the groups were equated as to numbers,

[1] F. W. Cozens, "Measuring the Results of Practice and Instruction," RES. QUART., A.P.E.A., March, 1931, p. 199; "Three Research Studies in Physical Education," RES. QUART., A.P.E.A., December, 1931, p. 67.

beginning track ability, spread of ability in the particular event practiced and general athletic ability score, but there were so many changes owing to uncontrolled conditions and to "drop-outs" that it was impossible to keep the groups equated. A spread of ability, however, was maintained in each group. Table II shows the groups as they finished the semester.

EXPERIMENTAL PROCEDURE

All men were given preliminary tests in the six events[2] during the first three periods of the semester and final tests in the six events at the end of the semester. During the course of the semester, tests were given to men working on the special events at more or less regular intervals. It was hoped that a test could be given in each special event on alternate periods but this was not always practicable.

For comparison with the experimental group we have records kept over a five-year period in the same events using a teaching procedure where all six events were alternated throughout the semester. This group will be called the "5-year group" and includes over 700 cases.

One of the first things which should be considered is whether or not the experimental group is a fair sample in so far as beginning ability is concerned. Table I shows that there are some differences in ability between the two groups but that those differences are not completely reliable, and that we may consider the experimental group a fair sample.

TABLE I

SHOWING STATUS OF EXPERIMENTAL GROUP IN BEGINNING PERFORMANCE

		Mean	S.D.	of M. S.E.	$\frac{D}{\sigma d}$
100-yd. Dash	Exp. Group	12.68^{s}	$.905^{s}$	.077	.86
	5 yr. Group	12.61^{s}	$.708^{s}$	.026	
120-yd. L.H.	Exp. Group	18.49^{s}	1.78^{s}	.151	.80
	5 yr. Group	18.36^{s}	1.56^{s}	.059	
Half-mile	Exp. Group	$2\text{-}49.4^{s}$	15.63^{s}	1.34	.00
	5 yr. Group	$2\text{-}49.4^{s}$	13.87^{s}	.53	
Run. Bd. Jump	Exp. Group	14′0.2″	22.55″	1.92	2.12
	5 yr. Group	14′4.6″	19.5″	.80	
12 lb. Shot	Exp. Group	27.59′	4.31′	.368	2.94
	5 yr. Group	28.75′	3.92′	.143	
Discus	Exp. Group	57.72′	12.60′	1.17	2.50
	5 yr. Group	60.86′	12.70′	.477	

[2] The six events were 100-yd. dash, 120-yd. low hurdles, half-mile run, running broad jump, 12 lb. shot put, and discus throw.

TABLE II

COMPREHENSIVE TABLE SHOWING MEAN SCORES

Experimental Groups	No. Cases	Total Improv. Track Score	Beginning Track Ability	G.A.A. Score	Best Score Improvement Sp. Event	100-yd. Dash Improvement	120-yd. L.H. Improvement	Half-mile Improvement	Run. B.J. Improvement	12 lb. Shot Improvement	Discus Improvement
						Sec	Sec	Sec	In	In	Ft
100 yd. Dash (without distance)	17	28.1	119	327	$.59^{s}$	.45	1.06	3.06	11.0	10.5	7.9
100 yd. Dash (with distance)	11	38.6	85	303	$.88^{s}$	.86	.92	11.2	10.7	25.2	10.7
120-yd. Low Hurdle (without distance)	10	48.8	87	324	1.52^{s}	.57	1.24	16.6	16.8	36.1	10.5
120-yd. Low Hurdle (with distance)	15	39.2	101	309	1.84^{s}	.51	1.60	17.1	9.3	13.0	10.7
Half-mile	23	36.2	112	308	19.5^{s}	.56	.74	16.8	11.4	19.9	8.5
Running Broad Jump	5	35.2	149	349	24.0″	.54	.84	5.2	16.6	25.0	5.8
12 lb. Shot Put (without distance)	16	34.0	92	313	41.2″	.37	1.21	6.5	15.0	38.1	9.7
12 lb. Shot Put (with distance)	12	37.5	114	312	37.7″	.49	.64	11.7	6.6	36.2	14.4
Discus Throw (without distance)	9	47.0	121	313	24.0′	.69	.69	8.8	13.7	34.6	19.6
Discus Throw (with distance)	20	35.8	86	310	23.2′	.57	1.06	12.4	8.9	19.2	20.6
Total Experimental Group	138	37.1	103			.55	1.00	11.3	11.4	24.0	12.15
5-yr. Group	700					.55	1.30	12.41	16.85	23.6	14.45

TABLE III

IMPROVEMENT OF EXPERIMENTAL GROUPS IN TERMS OF S.D. OF DISTRIBUTION OF BEGINNING ABILITY IN 5-YEAR GROUP

Experimental Groups	100-yd Dash	120-yd L.H.	Half-mile	Run. B.J.	12-lb Shot	Dis-cus	Total Improv.
100-yd Dash (without distance)	.635	.682	.221	.565	.223	.622	2.948
100-yd Dash (with distance)	1.214	.592	.808	.549	.536	.843	4.542
120-yd. L.H. (without distance)	.805	.798	1.198	.862	.768	.827	5.258
120-yd. L.H. (with distance)	.720	1.029	1.234	.477	.277	.843	4.580
Half-mile	.791	.476	1.213	.585	.423	.669	4.156
Running Broad Jump	.762	.540	.375	.852	.532	.456	3.517
12-lb. Shot Put (without distance)	.522	.778	.468	.770	.811	.764	4.113
12-lb. Shot Put (with distance)	.692	.411	.845	.338	.770	1.134	4.190
Discus Throw (without distance)	.975	.444	.635	.703	.736	1.543	5.036
Discus Throw (with distance)	.805	.682	.895	.456	.409	1.622	4.869
Total Experimental Group	.777	.643	.815	.585	.511	.957	4.288
5-Year Group	.777	.836	.895	.865	.502	1.138	5.013

SUMMARY OF TABLES II AND III

These are indications only because of the small number of cases which affects the reliability of the mean.

1. Improvement in general takes place in all events regardless of whether or not groups practice those events during the course of the semester. This improvement, with groups not practicing or receiving instruction in the event in question, is not as great as would be expected under normal conditions but is so large as to cast out the possibility of a chance or spurious improvement. Is there, then, some transfer of training taking place? The situation may be studied to see how it conforms to the generally accepted Thorndike theory[3] "that a change in one function alters any other only in so far as the two functions have as factors identical elements. The change in the second function is in amount that due to the change in the elements common to it and the first. The change is simply the necessary result upon the second function of the alteration of those of its factors which were elements of the first function, and so were altered by its training."

The two common elements in all events which seem most prominent are those of *speed of legs* and *increase of general bodily tone and muscular power* owing to regular activity over a period of time. It would appear that any activity involving these factors, such as boxing, tennis, handball, and the like, would have a tendency to cause improvement in any of the events listed, The element of endurance added to the program of four of the competing groups seems to have aided them to a considerable extent in their improvement in the half-mile run, but, except in the case of the dash men, this element has not been helpful in aiding general improvement, in fact, the hurdlers, shot putters and discus throwers who were not given distance running seem to have slightly more general improvement than the corresponding groups that were given distance running.

In the conduct of the experiment, dash men and shot putters were practicing at the same time. Likewise, hurdlers and discus throwers received practice and instruction during the same class period. Now, if observation of technique is any aid to improvement, or, if there is some transfer of training during observation, then the dash men should gain more in shot put ability than the hurdlers, the hurdlers should improve more in discus throwing ability than the dash men, and so on. However, we find no such condition, and might even make a general inference "that bleacher observation is not a good substitute for actual experience in an activity."

2. There is little doubt but what practicing on one event all semester increases the improvement made in that event over what would ordinarily be made when practicing six events alternately. The additional improvement made transposed into comparable units is as follows:

[3] E. L. Thorndike, *Educational Psychology*, Vol. II, (1919), Chap. XII.

IN SIGMA UNITS OF DISTRIBUTION BEGINNING PERFORMANCE

	Usual Improv. 6-event program	Improv. 1-event program	Gain with 6 times as much pr. and instr., percentage
Dash Men	.777	.875	12.6
Hurdlers	.836	.936	11.9
Distance Men	.895	1.213	35.5
Shot Putters	.502	.794	58.2
Discus Throwers	1.138	1.600	40.6

The additional gain with dash men and hurdlers hardly seems worth the effort when from three to five times as much improvement can be secured when specializing on distance running, shot putting, or discus throwing. This might logically lead to the conclusion that the time allotment to various events in a track class should put emphasis on the three having greater possibilities for improvement. The fact that all college men have had more or less experience in running short distances may account for the small gain in the dash and hurdles.

3. How do the various experimental groups live up to expectations in regard to making the best performance of the semester in the final test of their special event?

Dash men	perform to 88% efficiency
Hurdlers	perform to 85% efficiency
Distance men	perform to 86% efficiency
Shot Putters	perform to 99% efficiency
Discus Throwers	perform to 87% efficiency

It would seem logical to conclude from this study that atmospheric, track, and physiological conditions affect the shot put records less than those in any other event and that shot putters are more likely to live up to expectancy in a test than are any of the other groups.

4. Data offered in Table III show that efficiency in total improvement is lowered approximately fifteen per cent by specializing men in some one event as against working alternately on all six.

5. The least specific event improvement with the experimental group as a whole was made in the shot put but it is slightly more than is normally expected of men in a six-event program.

Just why we should expect less improvement in the shot put than any other event can only be conjectured. Possibly it is because the technique of shot putting is more difficult to acquire than that of any of the other events.

6. In the broad jump the experimental group performed only up to 68% of normal improvement.[4] This is probably due to two conditions—first, only five of the experimental group received practice and instruction in this event; and second, it has previously been shown that

[4] Normal expectancy refers here and elsewhere to the improvement made by the 5-year group practicing six events alternately.

learning to hit the take-off board alone will increase jumping ability more than a foot.

7. There is no question but what three minutes distance work adds materially to the improvement of individuals in the half-mile running test. In this regard, the increase of improvement of those groups having distance work over corresponding groups having no distance running is 71.5% and is also slightly better than normal expectancy. The improvement of men in the half-mile having no distance training is only about 62% of normal expectancy.

8. It may be interesting to make a comparison of groups as far as normal expectancy is concerned in events in which they had no training.

PERCENTAGE

	100 yds	120-yd L.H.	Half-mile	Broad Jump	Shot Put	Discus Throw
Dash men		77	25*	65	67	62
Hurdlers	97		134*	73	94	74
Distance men	102	57		68	84	59
Shot Putters	77	74	52*	70		81
Discus Throwers	110	73	71*	62	101	

*These percentages are for groups having no special training in distance work.

It is quite logical that hurdlers should improve to expectancy in dash work, since they received a great deal of sprint training. Also, the improvement of distance men in the dash is quite clear since they spent all of their time in running. It is not so clear, however, why the discus throwers should exceed expectancy unless, of course, foot work in making the discus turn is especially helpful in developing leg drive.

Just why practice in hurdling should be of special advantage in endurance running is not entirely apparent. Stride is bound to be lengthened in hurdling and this will undoubtedly be of advantage in distance running.

The leg drive developed in hurdling seems to be of advantage in shot putting while ability to handle weights is the cause of some transfer of training in both the weight events.

9. One other fact cannot be overlooked in our analysis of Tables II and III, namely, that improvement in broad jump performance is much less with those groups having distance work than with those not having such a program. Especially is this true with hurdlers, shot putters, and discus throwers. Just why this is true would be difficult to determine. It does not seem reasonable to suppose that a few minutes distance work per day would have a tendency to deaden the spring in a man's legs.

COMMENTS ON THE LEARNING CURVES

1. All of the curves follow the same general form as that indicated in such things as improvement in typewriting, telegraphy, copying a text in shorthand, and tossing and catching balls.[5] There are short time, day-to-day fluctuations, but in general a continued, upward progress is shown.

[5] See Arthur I. Gates, *Psychology for Students of Education*, pp. 251-256.

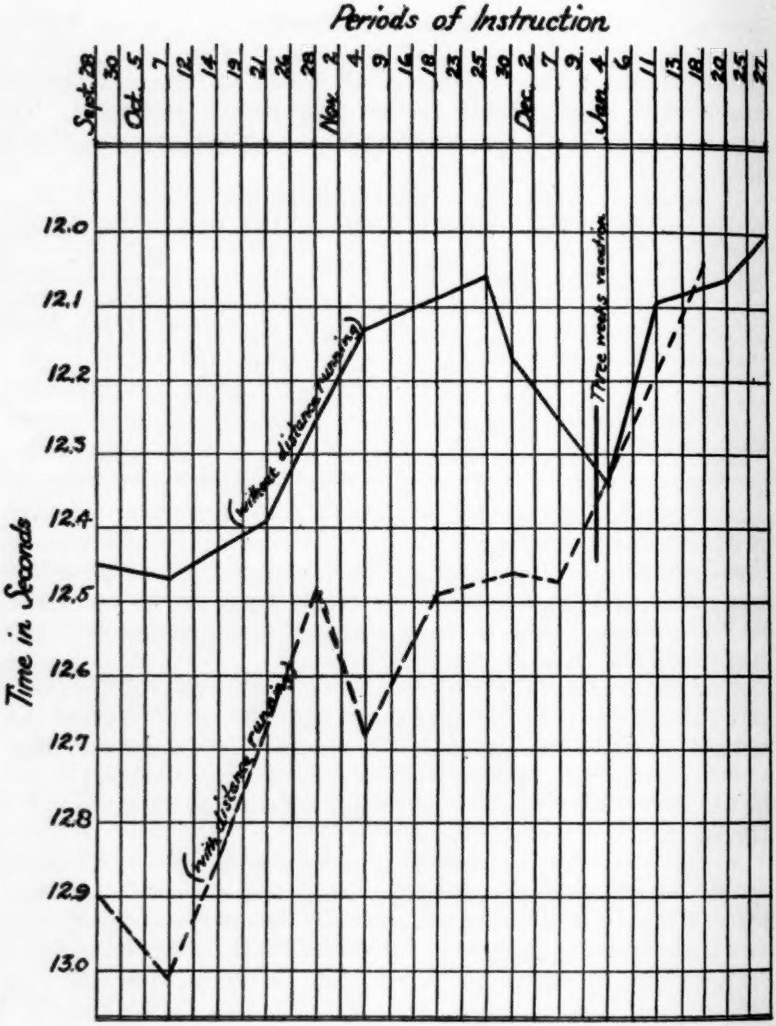

Fig 1. Learning Curve in 100yd. Dash

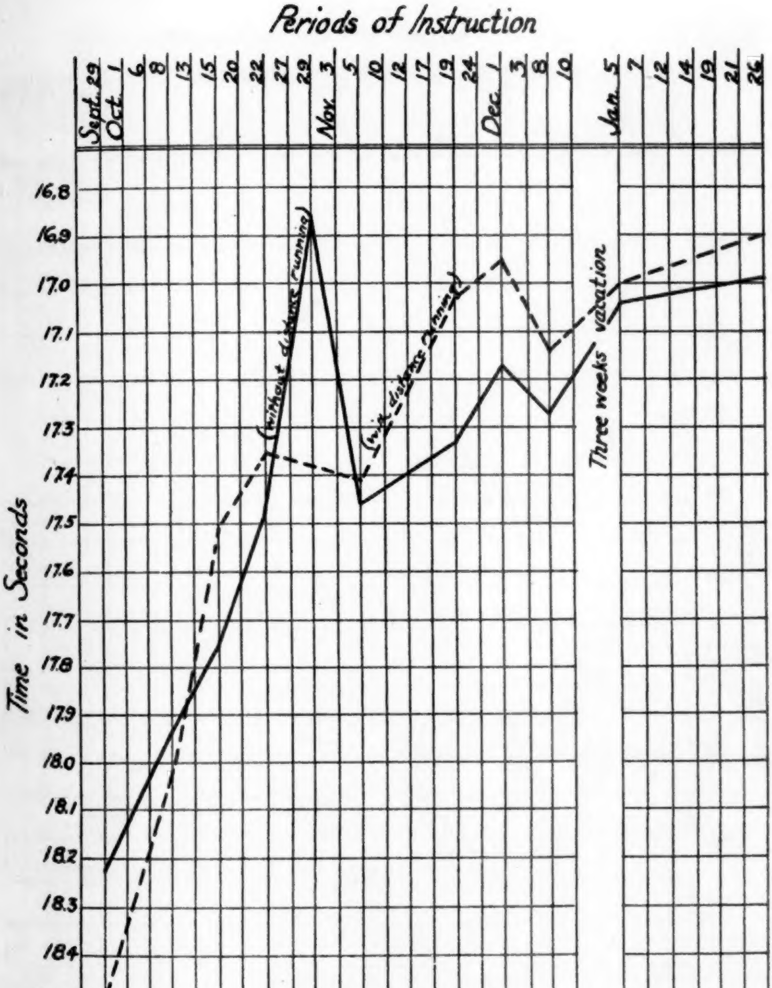

Fig. 2. Learning Curve in 120-yd. Low Hurdles

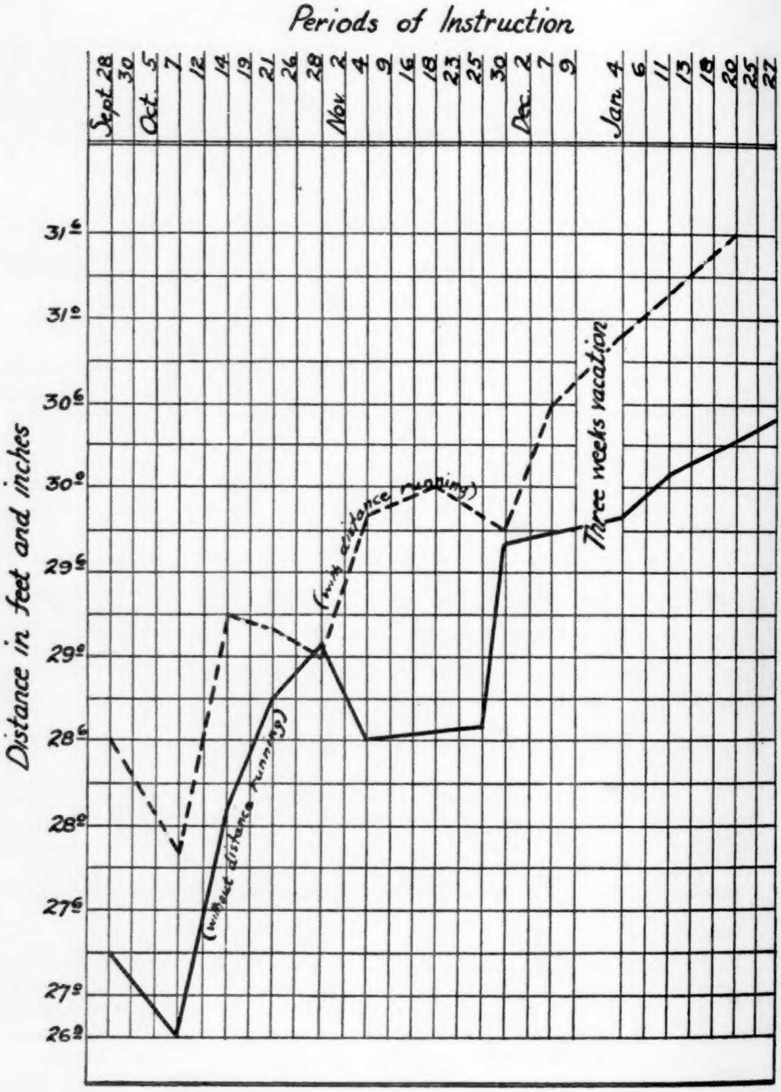

Fig. 3. Learning Curve in the 12-lb. Shot Put

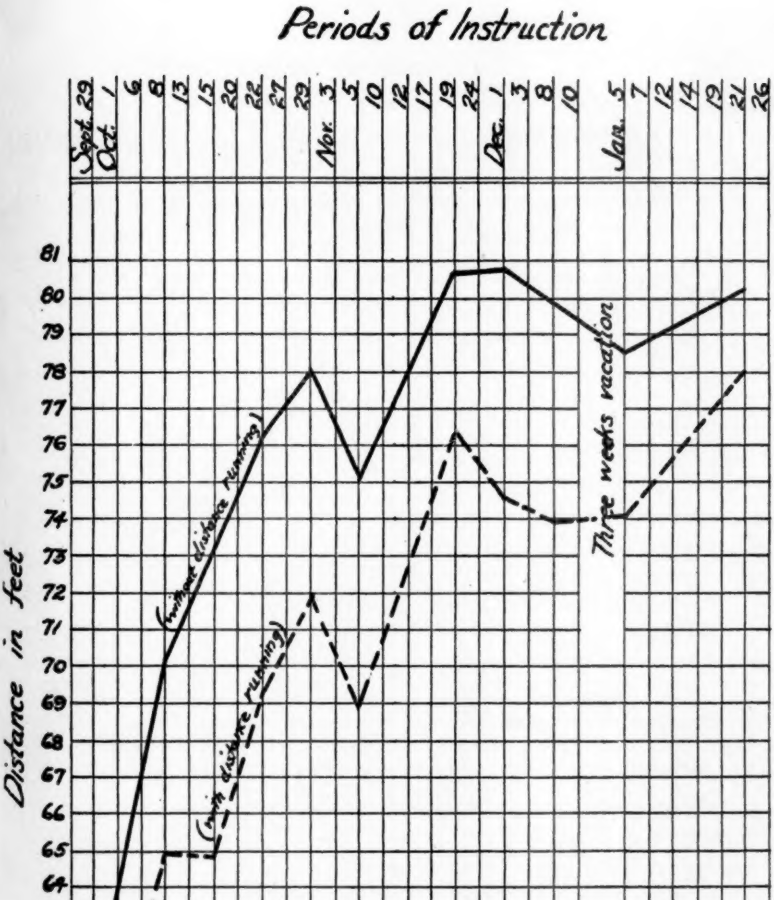

Fig. 4. Learning Curve in the Discus Throw

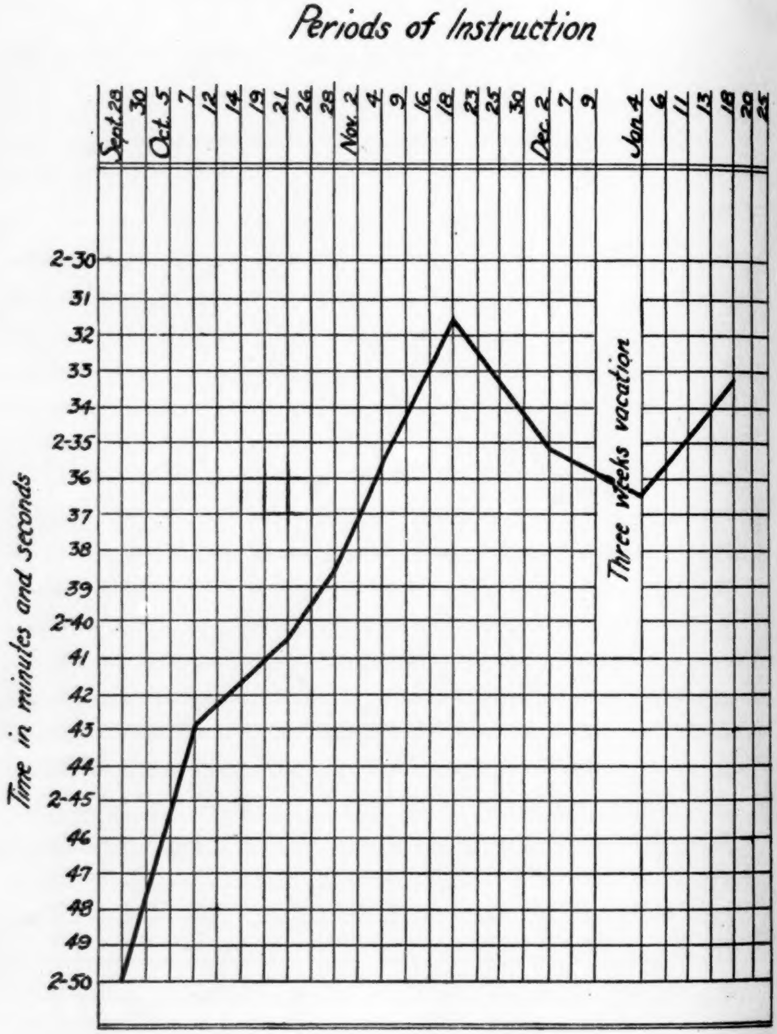

Fig. 5. Learning Curve in Half-Mile Run

2. The general depression in the curves on November 4 and 5 was undoubtedly due to atmospheric conditions—those days being cold and raw, with considerable wind.

3. In general, the best performances were made at the end of the semester. Exceptions to this generality may be mentioned in the case of the 120 yard low hurdles (without distance work) and the half-mile run. In the first instance, the peak of performance was reached about one-third of the way through the semester and in the case of the half-mile when about halfway through the semester. These peaks of performance were followed by depressions and never thereafter regained.

4. It is very interesting to note that in the case of the dash and the shot put, a downward fluctuation occurs at the outset. A possible explanation of this may be offered. In the dash, teaching is centered on form, including correct use of arms, legs, and feet, and, concentration on these items of form, as yet new to the men, results in a poorer performance than the initial one. In the shot put, the tendency without instruction is to "strong-arm" the shot, to put it out by "main-strength-and-awkwardness." Attention to form here also will temporarily retard improvement.

5. The rapid rise of the curve in the low hurdles undoubtedly results from some slight practice in getting over the hurdles. Many of the men have never before attempted to get over more than one hurdle in the course of a run and hence have a great deal of trouble in the initial attempt with foot work between hurdles. The actual hurdle form is not acquired in two or three practice periods.

The rapid initial rise in the discus throw is undoubtedly due to instruction and practice in learning how to hold the implement in the hand and how to let it go out of the hand. Instruction for the first few periods centers around these two points and making it sail through the air.

Some slight practice in building up the wind and legs due to running more than just a short dash will add greatly to the initial performance in the half-mile; in fact, this addition of endurance is as much as comes from an entire semester of activity where long runs are not required.

6. One very interesting fact may be noted in regard to the ability of the group after the three week Christmas vacation. One might think that there would be a considerable drop in improvement after a "lay-off" of this length but the curves show that such a drop is by no means general. The half-milers show a slight fluctuation downward as do also the dash men and the discus throwers who have had no training in distance work. There seems to be some indication that men who have had some distance training hold their condition better over a period of inactivity than men untrained in distance work.

7. A close study of the learning curves also brings out some indication that fluctuations in improvement are less severe with groups that have had some distance training, and that distance running has a "steadying" influence upon improvement.

8. Plateaus are reached in none of the events, indicating that instruction and practice might go on very profitably for some time. Just how long no one can say, but at least we know that twenty-eight to thirty periods of practice and instruction are not sufficient to bring improvement to a "stand-still." If this is true for one event, we can say with some certainty that men could profitably receive practice and instruction in six events with daily periods throughout a semester.

INDICATIONS OF IMPORTANCE TO TEACHING PROCEDURES

1. There is considerable evidence to show that we may expect an improved facility in the use of the body musculature by regular and continued physical activity even if it be in only one type of activity. The amount of improvement made in specific skills will depend to some extent at least on the identical elements involved in the training. Table IV shows the percentage of improvement made by groups not practicing specific events in relation to that made by groups which practiced the specific event only. No one would be foolish enough to believe that hurdling contains the identical elements of distance running but stride will undoubtedly be lengthened and more endurance built up than in dash work only. Because of the small number of cases involved, the percentage values listed give only rough indications.

TABLE IV

SHOWING PERCENTAGE IMPROVEMENT OF GROUPS IN SPECIFIC EVENTS (WHEN THAT EVENT IS NOT PRACTICED) IN RELATION TO EXPECTED IMPROVEMENT (WHEN THAT EVENT ONLY IS PRACTICED)

	Dash	Hurdles	Distance	Shot Put	Discus
Dash Men		69	37	44	44
Hurdlers	86		100	60	52
Distance Men	90	51		53	42
Shot Putters	68	66	52		58
Discus Throwers	98	65	67	64	

2. There is no evidence to show that possible observation is of assistance in acquiring technique. Apparently *we learn only by doing.*

3. Performance in the shot put seems to be more constant than in any other of the events used and, hence, in controlled experiments this event can be used very profitably.

4. In any activity program, a careful study of skill improvement should be made to see what skills can most profitably be emphasized.

5. Learning curves in "big-muscle" events follow the same general tendencies as many other curves involving mental reactions and small muscle groups.

6. A rather extended vacation period does not, as a rule, cause a "setback" in improvement. Men come back with increased enthusiasm. A change in program will probably help to relieve staleness and after an extended vacation we can expect men to pick up where they left off except perhaps in distance running where there is a slight drop in efficiency.

Experimental Study of Rhythm in Gymnastic and Tap Dancing*

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University of Illinois

MOTOR skills may be described from at least two points of view, viz., with respect to form or stance and with respect to rate or timing.[1] Form is well illustrated by the posture taken during a plain dive from the high board. The diver's stance, including the positions of the feet, legs, trunk, head, and arms, serves the primary purpose of giving grace and symmetry to the whole movement system. Although rhythm or timing is always a corporate part of every act of skill, it seems to be more obvious in motor activities such as dancing where the measured beat and evenly proportioned patterns of movement demand a keen appreciation of rhythm and a highly developed level of neuro-muscular coordination. The same facts hold true also of such an activity as juggling where the success of the performer in keeping a half-dozen objects in the air at the same time depends largely upon proper timing.

We do not mean to say, therefore, that form and rhythm are unrelated characteristics of movement systems. On the contrary, there must always be some form or stance upon which a rhythm is superimposed. In some activities such as card sorting, telegraph dispatching, or running the hundred-yard dash, the speed of movement is maximal. In other cases, however, the speed must be neither maximal nor minimal, but optimal.[2] As an illustration of a skill of this type, we may take the mile run. The runner has a "perfect" pace when he runs as fast as it is possible for him to run and still maintain the same pace over the entire distance.[3] For practical purposes, then, we may distinguish two phases of skill, viz., the stance phase and the pace phase. Whether the distinction is psychologically justifiable or not, it is a distinction commonly made in teaching athletic skills. As we have seen, it appears to have some foundation in fact, although up to the present time no adequate neural foundation for timing or pace has been discovered.

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*From the Laboratories for Research in Athletics at the University of Illinois.

1Stances may be either static or phasic. See C. R. Griffith, "Stance." *Ath. Jr.*, IX:3 (1929), 36–39.

2C. R. Griffith. "Timing as a Phase of Skill," *Jr. of Ed. Psychol.*, XXIII (1932), 204–213.

3 A. V. Hill. *Muscular Movement in Man*, Chapter VII, 1928.

A survey of the experimental literature on learning and on tests of motor performance seems to suggest that more attention has been paid to form of movement and to maximal rather than to optimal speeds.[4] The problems of pace and especially of rhythm have entered psychology to be sure through studies on the consciousness of rhythm[5] and upon the relation of these facts to such events as music.[6] Our own study, however, shall be limited primarily to the relation between stance and rhythm in some of the specialized athletic skills. Here, too, it is evident that form has attracted primary attention. Students of such matters spend hours in the analysis of moving pictures of accomplished athletes whose form in certain special skills seems worthy of attention. Later these pictures are shown to less skillful athletes whose desire it is to acquire better form. Rhythm, or pace, on the other hand, notwithstanding the fact that it enters just as intimately as does form into coordination, has undergone little experimental examination and finds little space in the terminology of sport.

Our general problem, then, has been to make a study of the pace factor in motor skills. Dancing was selected as a learning activity in which changes in rhythm or pace might be investigated. In more detail, we sought to find answers to such questions as the following, viz., (1) Does rhythm resemble form in that it may be acquired through practice, or is it an innate and, therefore, unlearned characteristic of motor skills? (2) How fast can rhythm or pace habits be acquired? (3) What are the effects of different types of dancing upon progress in acquiring rhythmic or pace habits?

An answer to these questions was sought from three groups of subjects. Group X was composed of sixteen subjects registered in a gymnastic and tap dancing class. It was called the experimental group. Group Y was made up of four subjects from another gymnastic and tap dancing class. Group C was composed of four subjects from an athletic coaching class in calisthenics. Fortunately, the schedule of this class included gymnastic and tap dancing during the second half of the semester so that the function of Group C was two-fold. During the first eight weeks, while engaging in calisthenic activity, it served as the control group. During the second eight weeks of the semester, records of its rhythmic progression in gymnastic and tap dancing provided an interesting contrast with records of its first eight-week activity and with the progress in pace control of groups X and Y over both eight-week periods.

In order to gain some knowledge of the previous history of the subjects with respect to pace habits or rhythm, each subject was asked to

[4] J. A. McGeoch. "The Acquisition of Skill," *Psychological Bulletin*, XXVIII (1931), 413–466.

[5] M. Bentley. *The Field of Psychology*, P. 240 ff. 1924.

[6] C. E. Seashore. *The Psychology of Musical Talent*, P. 288. Boston: Silver, Burdett & Company, 1919.

fill out a questionnaire concerning the length of time he had practiced activities of a rhythmical nature. These activities were grouped under four main headings, namely, athletics, dancing, marching, and music. Each was also asked to make an estimate of his conscious use of rhythms or of timing habits, both in and out of athletics. The results from the questionnaire were then made up into several tables, samples of which are given in Tables I and II. These data will be referred to below.

TABLE I

Approximate Training of Each Subject in Dancing, Marching, and Music

Group and subjects	Numer. rank of each subj. in rhythm. prof. at end of inves.	Experience in dancing	Experience in marching	Experience in music
X-1	8	4 years. ballroom	4 yrs. military	5 yrs. violin—sings.
X-2	13	None	1 mo. C.M.T.C. drilling	1 yr. cornet—sings.
X-3	12	None	1 mo. C.M.T.C. drilling	3 yrs. saxophone.

TABLE II

Approximate Training of Subjects in Athletics and Estimated Conscious Use of Rhythms

Group and subjects	Numer. rank of each subj. in rhythm. prof. at end of inves.	Experience in athletics	Conscious use of rhythms
X-1	8	8 yrs. swimming, 6 yrs. baseball, 3 yrs. football	Makes up own tunes while riding. Whistles while walking.
X-2	13	4 yrs. calisthenics	Rhythms recur while riding on trains. Whistles while walking.
X-3	12	1 yr. track, 1 yr. basketball.	While riding, rhythms suggest familiar tunes. Whistles while walking.

The experimental data were gained in the following way. Each subject stood on a brass contact plate with toe caps or brass sandal plates attached to his feet. A switch was then closed to bring a metronome into circuit with a bell which sounded at each beat of the metronome. The subject was cautioned to pay strict attention to the bell and to mark time as nearly as he could with the pace set by it. In the process of marking time, the heels were raised approximately two inches from the contact plate and should any subject have made a perfect score his toes would have struck the contact plate simultaneously with the ringing of the bell throughout the experimental period. That is, it was assumed that normal reaction time to an auditory stimulus should disappear after the first few measures since the subject would learn to keep in rhythm with the metro-

nome in much the same way that a track man leaves to "beat the gun."

Two electric time markers, one in circuit with each toe cap, recorded on a slowly revolving kimograph sheet the contacts made by the toe caps with the brass plate. A third electric time marker placed below the other two was in circuit with a fifty d. v. magnetic tuning fork, the metronome, and the bell. It was the function of this marker to indicate on the kimo-

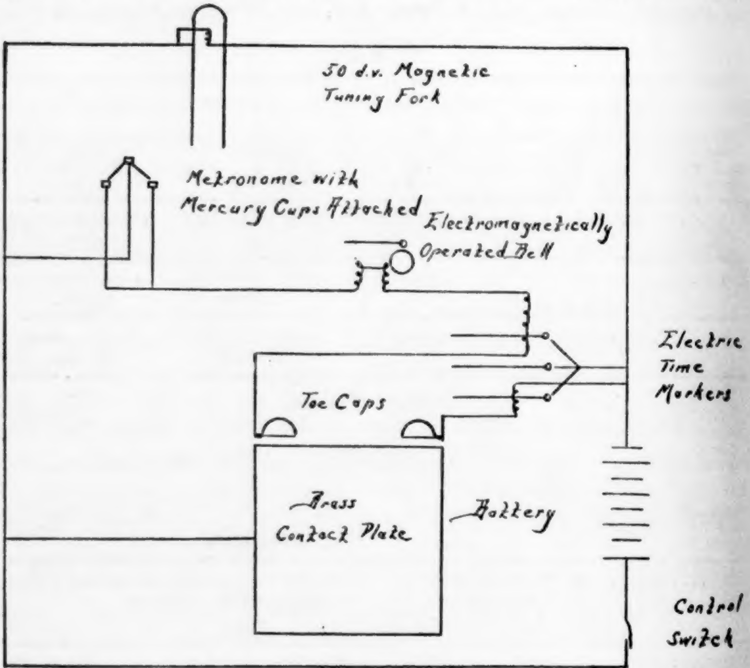

FIG. 1. Diagram of electrical connections in apparatus used in the investigation of foot rhythms.

graph sheet exactly the point at which the bell rang. The impetus for the ringing of the bell came, of course, from the steadily beating metronome as is illustrated by Figure 1. In addition to the three electric time markers, the tuning fork was also in contact with the smoked kimograph sheet, thus leaving a time line representing fiftieths of a second.

The method of calculating the accuracy of foot rhythms is illustrated in Figure 2. Since it was not likely that the subjects would tap on the brass plate simultaneously with the bell, the extent of error was chosen as the scoring criteria for the test. Its measurement proved to be relatively simple and highly accurate. The upper two electric time markers indicated the points at which each foot came in contact with the contact plate. The lower time marker indicated the exact point at which the bell

rang. A perpendicular line drawn from each of these points up to the time line left by the tuning fork disclosed (1) the exact interval that elapsed between the contact of one foot with the plate, and the ringing of the bell, or (2) the time that elapsed between the ringing of the bell and the contact of a foot with the plate. In the first case, the subject would make contact with the plate ahead of the ring, and in the second case he would make contact with the plate after the bell had rung. In cases where no error existed, the subject's foot came in contact with the plate simultaneously with the ringing of the bell.

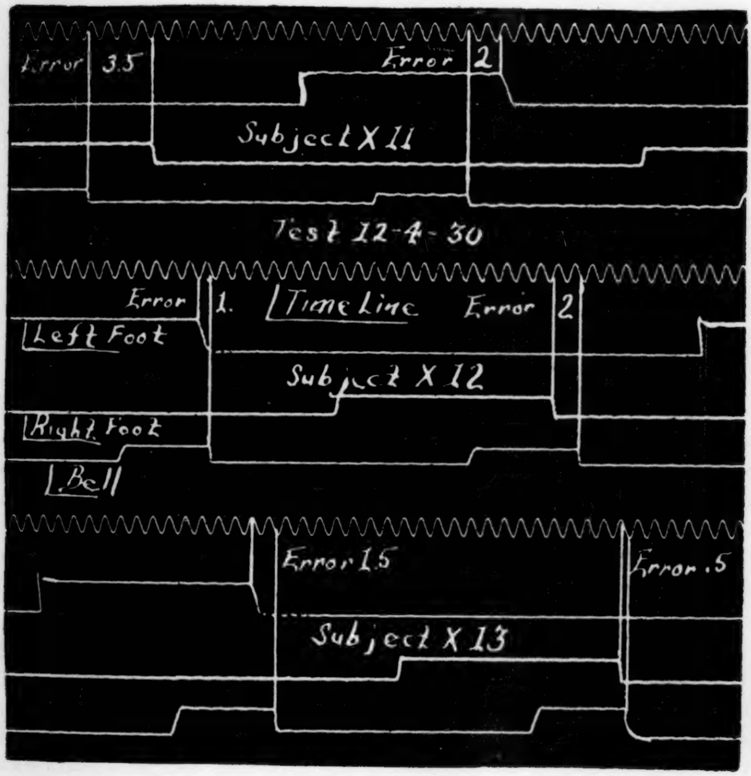

FIG. 2. Section of a kimograph record illustrating method of gaining record together with a sample of the scoring technique.

The method of recording the data from this experiment is illustrated in Table III. Each of the figures in this table represents errors in rhythmic pattern measured in fiftieths of a second. In reading the kimograph sheets after each trial period, twenty repetitions of marking time in place were picked from the center of each subject's record. The errors of these twenty

repetitions, ten with the left foot and ten with the right, were then recorded in the table. The average error made by the left and the right foot for each subject during every trial period was then computed and transferred to other tables. These tables will be presented below.

TABLE III

SAMPLE TABLE SHOWING FOOT RHYTHM ERRORS IN MARKING TIME RECORDED IN FIFTIETHS OF A SECOND

Trial Date—10-9-30

Subjects		1.		2.		3.		4.	
Foot		L.	R.	L.	R.	L.	R.	L.	R.
R									
E	1.	1.50	2.00	1.50	0.00	0.50	1.00	3.50	3.50
P	2.	2.50	2.00	1.00	1.00	0.00	1.00	3.50	2.50
E	3.	1.50	2.50	1.00	2.00	4.00	2.00	1.50	2.00
T	4.	1.50	2.50	1.00	0.00	2.00	3.00	2.00	0.00
I	5.	4.00	4.00	0.00	0.00	3.00	3.00	1.50	2.00
T	6.	4.00	4.00	3.00	2.00	2.50	2.50	2.50	2.00
I	7.	2.50	3.50	1.50	1.00	3.50	4.00	2.50	2.00
O	8.	1.00	2.00	0.00	2.00	3.00	4.50	2.00	2.50
N	9.	3.00	3.00	1.00	1.00	3.50	5.00	3.00	2.00
S	10.	2.50	3.00	1.00	1.50	4.00	5.00	0.50	0.50
Totals		24.00	28.50	11.00	10.50	26.00	31.00	22.50	19.00
Aver.		2.40	2.85	1.10	1.05	2.60	3.10	2.25	1.90

Aside from the foot rhythm test, two other tests were given the subjects for the purpose of drawing a comparison between them and the results of the foot rhythm investigation. The first was the Seashore rhythm test.[7] This test is ordinarily used to test rhythm of the hands, but was modified to suit the needs of this investigation by the construction of a spring contact foot pedal. The second supplementary test given the experimental groups was a test of auditory reaction time.[8] The significance of this material will be seen in the presentation of data.

In short, then, the experimental procedure consisted of the following steps. In the ordinary course of teaching gymnastic dancing, the subjects of this experiment were to undergo training in the pace or timing of a series of movements rather than in their form. Tests of pace or timing were made by asking the subjects to tap with their feet on a brass plate against a rhythm set for them by a metronome. Errors in rhythmic pattern could be measured in fiftieths of a second and these errors constituted a record of the subject's skill. The data to which we now turn will show how instruction in gymnastic dancing is related to these tests of foot pacing or timing.

[7]R. H. Seashore. "Stanford Motor Skills Unit." *Psychological Monographs*, XXXIX:2 (1928).

[8]The apparatus used in this experiment was the standard Dunlap set-up (Stoelting).

Table IV represents the average error for both feet of each of the subjects in all three groups over the entire experimental period. The individual error score which was determined by averaging the errors of the left and right foot is also included. It was from these individual scores that the numerical ratings in rhythmical proficiency were computed. The subject having the lowest average error was, of course, given first place and the subject with the second lowest average error was given second place, etc.

TABLE IV

Average Errors in Foot Rhythm Measured in Fiftieths of a Second

				Group X				
Subjects	1.		2.		3.		4.	
Foot	L.	R.	L.	R.	L.	R.	L.	R.
Aver.	1.56	1.22	3.13	1.83	1.58	1.43	1.53	1.02
Indiv. Score	1.39		1.98		1.50		1.27	
Subjects	5.		6.		7.		8.	
Foot	L.	R.	L.	R.	L.	R.	L.	R.
Aver.	1.39	1.52	2.05	2.30	1.50	1.41	2.40	2.25
Indiv. Score	1.45		2.18		1.45		2.32	
Subjects	9.		10.		11.		12.	
Foot	L.	R.	L.	R.	L.	R.	L.	R.
Aver.	1.38	1.23	1.23	1.12	2.90	2.30	2.35	1.78
Indiv. Score	1.30		1.17		2.60		2.06	
Subjects	13.		14.		15.		16.	
Foot	L.	R.	L.	R.	L.	R.	L.	R.
Aver.	1.38	1.41	1.31	1.20	2.10	2.01	1.49	1.16
Indiv. Score	1.39		1.25		2.05		1.32	
				Group C				
Subjects	1.		2.		3.		4.	
Foot	L.	R.	L.	R.	L.	R.	L.	R.
Aver.	2.43	2.35	1.08	1.03	2.05	2.30	1.43	1.05
Indiv. score	2.39		1.05		2.18		1.24	
				Group Y				
Subjects	1.		2.		3.		4.	
Foot	L.	R.	L.	R.	L.	R.	L.	R.
Aver.	1.45	1.51	1.39	1.10	1.64	1.23	1.50	1.20
Indiv. Score	1.48		1.24		1.43		1.35	

Table V represents a summary of the figures found in Table IV. Here the scores for left and right feet are averaged and presented with their probable errors. The mean of these two scores (left and right foot) indicates a single group score for all tests.

TABLE V

SUMMARY OF ERROR SCORES IN GROUPS X, Y, C.

	X	Y	C
Left Foot	$1.83 \pm .49$	$1.49 \pm .07$	$1.74 \pm .49$
Right Foot	$1.57 \pm .37$	$1.26 \pm .12$	$1.68 \pm .64$
Average	$1.70 \pm .43$	$1.37 \pm .09$	$1.71 \pm .56$

The computation of a group error score after each of the nine tests enabled the experimenter to keep a graphic record of rhythmic progress in the three groups. (See Fig. 3.) The most outstanding details relating to this progression are listed in Tables VI and VII.

The indications in Table VI gain more significance by comparing the

TABLE VI

EXPLANATION OF RHYTHMIC GAIN OR LOSS IN GROUPS X AND Y

Week	Test No.	Rhythm Significance	Apparent Reasons
1	2	Gain	Increasing acquaintance with apparatus and technique.
2	3	Gain	Mastery of simple rhythms taught in early learning exercises.
3	4 (X) (Y)	Gain Loss	Continuance of simple rhythms. None.
5	5	Loss	Muscular stiffness and fatigue brought about by difficult learning activity.
7	6	Gain	Conditioning of muscles (absence of muscular stiffness) and mastery of difficult exercises practiced previous to fifth test.
9	7	Loss	This drop was anticipated. It was caused by changing from gymnastic to clog dancing, and the music was changed from fox-trot to waltz time.
11	8	Loss[9]	Lack of effort and deviation of subject's attention.
14	9 (X)	Gain	Continuation of learning during period of inactivity.
	(Y)	Loss	Discontinuation of learning activity over holiday period.

[9]The increased error displayed in this test may have been due in great measure to the lack of effort and deviation of attention of the subjects caused by the hilarity in the anticipation of their holiday recess. It was the writer's misfortune on this last trial date, a day before classes were dismissed, to have exercised less control over these twenty-four university freshmen than had ever been the case previous to or following that trial date.

TABLE VII

EXPLANATION OF RHYTHMIC GAIN OR LOSS IN GROUP C

Week	Test No.	Rhythm Significance	Apparent Reasons
1	2	Loss	Participation in activities of little rhythmic value.
2	3	Gain	Increasing acquaintance with apparatus and technique.
3	4	Gain	None.
5	5	Gain	None.
7	6[10]	Gain	None.
9	7[11]	Gain	Engaged in rhythmical learning activities for the first time during the investigation. Also added length of practice periods.
11	8	Loss	Lack of effort and deviation of subject's attention.
14	9	Loss	Discontinuation of learning activity over holiday period.

records of group C, the control group, whose members for the first seven weeks were not engaging in dancing activity, with groups X and Y.

An interesting contrast is found in a comparison of the average errors of groups X and Y, on the one hand, with C, on the other, over the seven- and eleven-week period. Table VIII illustrates the superiority in skill of the groups taking dancing for the whole semester over the group which received instruction in dancing during the latter half of the semester only.

TABLE VIII

SIZE OF AVERAGE ERROR SCORES OF GROUPS X AND Y AS CONTRASTED WITH AVERAGE ERROR SCORE OF GROUP C FOR THE SEVEN- AND ELEVEN-WEEK PERIODS

Average Group Errors

	X	Y	C
7 weeks	.0332	.0276	.0374
11 weeks	.0332	.0278	.0340

Seven Weeks	*Eleven Weeks*
Group X—11.3% smaller than C.	Group X—1.8% smaller than C.
Group Y—35.5% smaller than C.	Group Y—19.6% smaller than C.

[10]The increase over this six-week period, however, does not bring the group down to the level indicated by the first test.

[11]From the end of the seven-week period to the end of the nine-week period (the first two weeks in which group C engaged in dancing activity), the curve for the group indicates the most pronounced gain in rhythm made by any of the groups during the experiment.

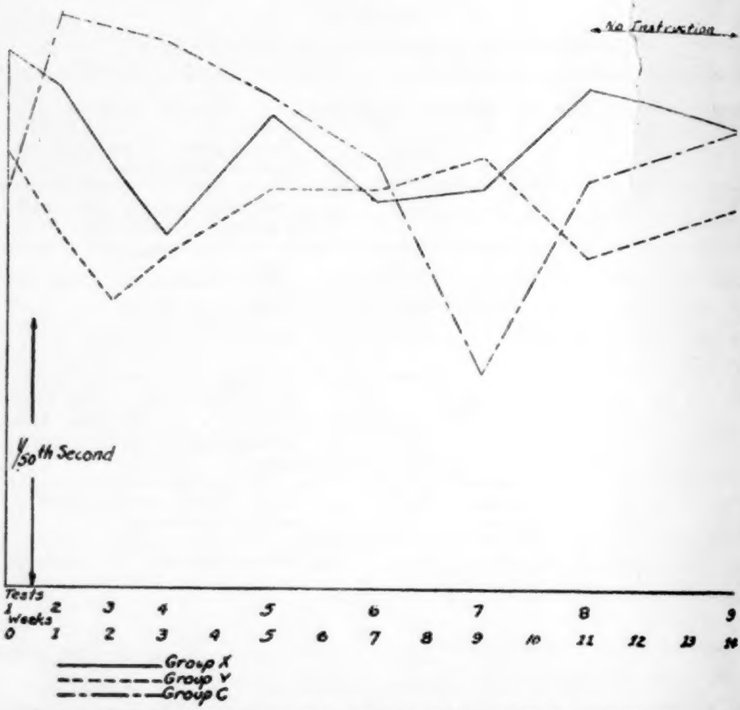

FIG. 3. Graph showing progress in rhythm of Groups X, Y, and C over a period of eleven weeks; also the effects of a delayed test (9)* given after a three-week holiday period. NOTE.—Rhythmic gain is indicated by the downward tendencies of the curves and rhythmic losses are indicated by the upward tendencies.

In only one instance does group C, the half-semester dancing group, closely approach the lowered error score of the two full-semester dancing groups. The instance mentioned is in the comparison of the average error scores of groups X and C over the eleven-week period. The inference here is that the average error of group X is 1.8 per cent smaller than that of group C. This comparison is actually an injustice to group X because of the difference in the number of subjects in the two groups. A justifiable comparison from this standpoint, as mentioned previously, lies between groups Y and C. A comparison at seven weeks of these two groups discloses that the average error score of group Y was 35.5 per cent smaller than group C, and in the comparison at eleven weeks (see Table VIII), group Y average error score is 19.6 per cent smaller than that of group C. The marked decrease in the average error score of group C can be attributed to the participation in dancing and to the lengthened practice periods in that activity.

In an endeavor to rank the experimental subjects according to the

amount of previous experience each had gained in four different activities, namely, dancing, marching, music, and athletics, the questionnaire previously given out was graded although no attempt was made to grade the consciousness of rhythm of the subjects. While the grading of the questionnaires is in nowise completely objective, the results bring out certain points which could aid in the explanation of similarities between previous experience in the activities mentioned and the three different tests given during the experimental period.

In all three groups, taken as a unit, no significant correlation was found to exist between the results of any one of the three tests given and previous experience in the activities listed. (See Table IX.) A correlation of $.51 \pm .10$ was found to exist when the individual rankings in each of the tests were averaged and the average rank correlated with the amount of previous experience.

TABLE IX

Correlation Table Showing Relationship Between Each of the Three Tests and the Questionnaire Ranking

		2	3	4
1. Foot rhythm test				
2. Seashore rhythm test	1.	$.155 \pm .122$	$.909 \pm .234$	$.858 \pm .975$
3. Auditory reaction time test	2.		$.156 \pm .138$	$.223 \pm .675$
4. Questionnaire rank	3.			$.098 \pm .113$

A study of Fig. 4 will make it appear that different types of dances affect foot rhythms in a variety of ways. First, it might be logical to mention the fact that simple dance steps, incorporating only the most fundamental movements, seem to improve elementary rhythms faster than complicated dance steps incorporating complicated rhythms. With this principle in mind, it is the usual practice for commercial teachers in beginners' dancing classes to follow a graded progression of exercises until the pupil is beyond the fundamental rhythm stage. Once this point is reached, more difficult steps embodying increasingly complicated rhythms are taught to the pupils as fast as they can learn them.

The nature of the progression used in the physical education dancing course from which the subjects in this research were selected deviated from the ordinary commercial progression for a definite reason; viz., in the physical education dancing course mentioned, it was the objective of the class to learn five dance routines, three of gymnastic and two of tap dancing. The time allotted to cover this material was limited to fourteen hours of actual instruction. The same five routines in a commercial dancing class would likely have taken up double this amount of time. As a result, the progression used in the physical education class was "steep" in comparison to the usual commercial procedure.

The conclusions of the writer, after investigating the rhythm scores of groups Y and C, hold closely to the statements above concerning progressions.

Fig. 4 presents the relationship between combined error scores of groups X and Y over all nine test periods and the sequence of dances taught during the investigation. No attempt will be made here to explain the progression of the curve although this has been done in the original research.[12]

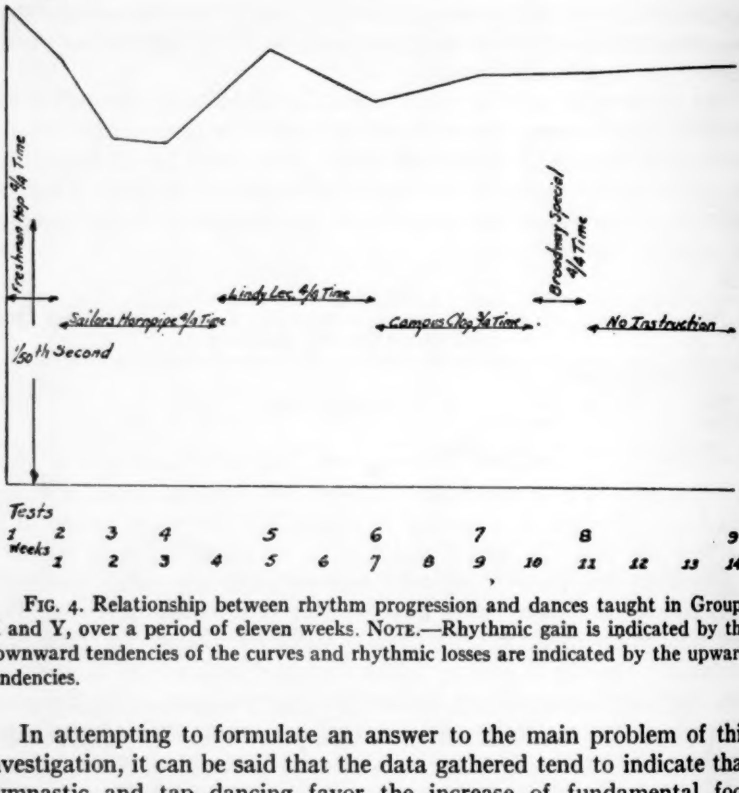

FIG. 4. Relationship between rhythm progression and dances taught in Groups X and Y, over a period of eleven weeks. NOTE.—Rhythmic gain is indicated by the downward tendencies of the curves and rhythmic losses are indicated by the upward tendencies.

In attempting to formulate an answer to the main problem of this investigation, it can be said that the data gathered tend to indicate that gymnastic and tap dancing favor the increase of fundamental foot rhythms of students enrolled in these courses of activity.

(1) The data in this research indicate that rhythm is not an innate faculty. The information secured in questionnaires given out in connection with the study suggests that those subjects having the most previous training in rhythmic activities made the best showing in the rhythm tests given, and that those subjects having the least previous training in rhythmic activities made the poorest scores in the tests given. The fact that the foot rhythms of most of the subjects varied throughout the investigation is apparently another indication that rhythm is not innate. Should rhythm be an innate faculty, it is the writer's opinion that the

[12] See K. J. McCristal, An Experimental Investigation of the Foot Rhythms Involved in Gymnastic and Tap Dancing. University of Illinois, Master's Thesis in Education, 1931.

changes in rhythm during the eleven weeks of experimentation would have been negligible.

(2) With reference to the speed with which rhythm can be learned, the writer cites the rhythmic error score of group C in the seventh foot rhythm test. This error score is approximately half as great as the next smallest error score in any of the groups, the speed of rhythm acquisition here being due primarily to the daily hour practice period, five times a week. The apparent conclusion, then, is that the speed with which rhythm may be learned depends upon the intensity and length of practice periods and the nature of the movements practiced.

(3) The results of this investigation tend to suggest that dances incorporating simple rhythms increase fundamental foot rhythms more rapidly than dances involving complicated rhythms.

(4) Perhaps the most important result of our study has been the creation and standardization of a method of measuring, with some degree of accuracy, variations in the rate at which a simple muscular movement may be executed. A way has thus been opened for many other studies on the timing or pace phase of skills, a fact that cannot help but be of significance in the field of coaching.

Projects In Applied Physiology

An Experiment in Teaching Method

By Frances A. Hellebrandt, M.D.
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A COURSE in physiology having reference to the specific problems of physical education presupposes a background of general physiology. Before the physiology of exercise can be adequately studied, the student must be equipped with the basic and fundamental concepts of the mechanisms by which the various organ systems of the human body carry on their functions. These in turn must be erected upon a foundation taking root in the fields of biology, chemistry, physics, and human anatomy. Such is the training of the group of students with which this experiment in the project method of teaching is concerned.

Courses in applied physiology frequently consist of the theoretical study of one of the standard textbooks in the field, most of which devote a generous portion of their content to a consideration of the intimate mechanisms of the contraction of muscle and to the responses of the cardiovascular system to exercise. No especial effort is made to teach the principles of scientific method and the techniques peculiar to the physiologist. The theoretical considerations may or may not be illustrated by experiments, most of which are, in the mind of the student, only remotely related to the practical problems which confront him in his work in the gymnasium and on the athletic field, and in his practice teaching. For example, much time is consigned to the gastrocnemius of the frog. The beating of the turtle's heart is recorded. The effects of the intravenous injection of adrenalin upon the blood pressure of a dog are noted. A few experiments may be done upon living man. The student steps up and down a specially constructed bench a specified number of times in a given number of seconds and observes the changes in his own heart rate and blood pressure in response to this constrained exertion. He may even twirl the handle of an egg beater to note its elevating effects upon the rate of his metabolism.

All this is well and good. To the physiologist, versed in the ramifications of his field, each experiment demonstrates some important principle, and throws light upon the reason why the business men's class gets dyspnoeic at volleyball, or the boy at camp has such an inordinate appe-

tite, or the human being can run so fast and no faster. But to the student, equipped with only a preface to this knowledge, there is but a vague and unimportant link between the experiments of the physiology laboratory, and the problems that he half senses as he coaches and participates in games. We who teach presuppose that, once he meets with scientific method and familiarizes himself with the physiological aspects of exercise, he can carry-over that which he once knew and apply it to answer the questions which come to his mind as he passes a group of mountain-sick climbers, or as he marvels at the staying power of the well-trained athlete in a gruelling contest. We half expect, as he steps out of the laboratory into the field of practical physical education, that he will automatically begin to do research.

The rare student may seize upon a problem, and solve it. By and large, he fails to, not for want of interest, but because we have not taught him how. There are many students with an abundance of problematic ideas. Few have the initiative to find a method of solution. Fewer still, the discipline and perseverance to follow the scent to its conclusion. For a certain measure of this indifference we are at fault. Nor can we teach the student by a pointing of the way, by academic discussions and admonitions. The only way is through *doing*. When a student digs down and solves some problem of personal importance related to his major field of interest, he begins to really learn.

THE purpose of this experiment in teaching method, was three-fold. First, to make the application of physiology to physical education useful, rather than theoretical. Second, to teach, through actual experience, the elementary concepts of practical research. Third, to liven the teaching of a course allied to physical education through the simple expedient of uniting it with the student's field of major interest.

This mode of teaching had its origin four years ago, with the informal institution of "voluntary research," as an extra-curricular activity offered in conjunction with the regular course in physiology for physical education students. So beneficial did it seem to those who spontaneously entered into it, that two years later it was modified and incorporated into the course in applied physiology. It has been tried on two successive classes, composed of women majoring in physical education and in their third year at college. The groups have been relatively well grounded in the basic sciences. Before studying the physiology of exercise, they have had training in biology, physics, general chemistry, quantitative chemical analysis, elementary physiological chemistry, human anatomy, and general physiology. Their introductory course in physiology is comparatively extensive, meeting for ten hours a week for one eighteen-week semester. During the following term, six hours a week are devoted to the

physiology of exercise. The classes studied were small, averaging twenty-five students, and were taught by two full-time faculty members, both of whom had majored in physical education during their undergraduate years. These instructors participated in some of the practical work offered by the physical education department, being thus familiar, in general, with the professional teaching methods and attitudes to which their students were subjected. The members of the physical education staff were cooperative, suggesting problems, and encouraging student research.

Equipment and laboratory space were in many respects ideal. The students had at their disposal one large general laboratory and three small research rooms. Besides a liberal supply of the usual apparatus, they had such special equipment as a rowing machine, tread mill, arm, finger, and foot ergographs, a Pronybrake hand ergometer, steadiness apparatus, instruments for schematographic studies of center of gravity and body mechanics, a basal metabolism machine specially modified for use during mild bouts of stationary exercise, and three bicycle ergometers, one of which was equipped with an electro-dynamic brake.

During each first term propaganda was carried on along three carefully premeditated lines. Historical sketches of the classical contributions to the branches of physiology especially interesting to the physical education student were given, stressing the human side of research and the personalities of its adventurers. This was supplemented by the posting of abstracts and reprints of the researches of contemporary workers. The abundance of studies of interest and of importance to the physical educator appearing in the various scientific journals is surprising. Much is being done by investigators in the fields of general medicine, nutrition, physiology, and biochemistry. Finally, a consistent effort was made to allude to every possible application of the material being studied at the moment to current problems in physical education. Small, carefully delimited projects, so-called "minor researches," were occasionally suggested and offered as "increased opportunity work," to be voluntarily undertaken by an interested student. When completed, these were reported to the entire class by the responsible pupil or by the teacher, or were posted for inspection. During the first term, there thus gradually developed, a critical, appreciative alertness, and the beginnings of an investigative turn of mind.

That the one year of work in physiology was to culminate with the presentation of an "original experiment," was announced at the beginning of the second semester. The students were encouraged to think in terms of physiology when attending their practical and technique courses in physical education. The laboratory work itself was limited as far as possible to experimentation on the human being, the usual fundamental experiments having already been performed in the introductory course. All laboratory

work ceased from four to six weeks before the end of the term. The remainder of the semester was entirely devoted to actual experimentation on the "original problem" which had been selected and planned prior to the cessation of the routine work.

ABOUT 60 per cent of the students had enough creative ability and originality to select their own problems. Their tentative plans were frequently ambitious, but these were readily scaled down. The students conferred informally with the instructors, and their projects, if hazy, were clarified and very carefully delimited, being kept rigorously within the scope of the pupils' technical skill and the time at their disposal for the solution of each problem. Consistent effort was made to use equipment which was sufficiently precise and accurate to make the study worth while. Probably nothing is more detrimental to the student's development in research, than to expect him, in the early and unproductive stages of his training, to work with crude and inaccurate apparatus. Meticulous, painstaking care and accuracy of observation are inherent to scientific method. Nothing is more futile than to try to teach these attributes with the use of totally inadequate instruments of precision.

About 20 per cent of the students lacked sufficient creative ability to select their own projects. They were, however, suggestible and set to work upon a problem when a number were tentatively outlined by the instructor. The remaining 20 per cent were lacking in both imagination and originality. Confronted with a dozen problems they failed to grasp their possibilities and were taken aback by the necessity of creating the superstructure of an experimental procedure upon anything as intangible as an idea. A suitable project was planned only with the aid of considerable guidance.

The students then proceeded independently upon their problems, working in the laboratory, the dormitory, the athletic field, the swimming pool or the gymnasium, depending upon the nature of the question to be solved. Although they were encouraged to work individually, when a project was jointly created, and the scope of the problem warranted, two students worked together. About 10 per cent of the projects were so conceived and executed.

Instructors were available for consultation and advice during the periods usually allotted to the laboratory work. At the end of the designated period, formal typewritten reports of the method, experimental results, and physiological significance of the projects were submitted. These were evaluated on the basis of their ingenuity, accuracy, extensiveness, and the display of acumen in the drawing of conclusions.

The last laboratory period of the semester was turned into a demonstration or "field day." All of the papers were on exhibition in the main laboratory, accompanied by the exact set-up of the apparatus used, and by illustrative records. Three or four of the best ventures were presented in

abstract by the responsible students. The demonstration was attended by sophomore and senior classmates, and by faculty members of the physical education and physiology departments.

THE results of this experiment were interesting from a number of points of view. In the two small groups studied, the excellent students in theoretical and routine laboratory work were not the ones who invariably presented the best researches. The "A" student frequently grasps things quickly and remembers well, but is lacking in originality and the ability to apply knowledge to a practical situation. These deficiencies do not come into prominence in the usual course. In many instances, research needs hard, systematic, assiduous effort more than flashes of ingenuity and brilliance. The project method was probably most developmental for the average, reasonably capable student. The members of this group, as a whole, were enthusiastic and conscientious. What their discussions lacked in acuteness of perception was made up by the scope of their observations and the frankness of their enthusiasm. The inferior students met with hazards along every step of the way. Errors crept into their methods and their results were unreliable and ill considered. The project method did little to raise the level of their scholarship. They seemed to learn neither more nor less than from the usual routine laboratory procedure.

The projects did much to stimulate general interest in physiology and served to demonstrate it as a science which can solve the practical problems which loom with conspicuity upon the field of view of the professional physical education student. The average pupil came to grips with a type of material, the existence of which he would not have been conscious, save for the necessity of digging deeply into the ramifications of some problem. Physiology is so large a field of knowledge that it must of necessity be taught in systems. We sometimes forget to rebuild these into a composite man. The minor researches of these students served not only to re-enforce and strengthen their knowledge along certain specific lines, but they frequently lead to the discovery that instead of studying an isolated phenomenon, the experiments demonstrated the functioning of a beautifully integrated whole.

One of the most important lessons learned was that of appreciation and critique. The path the scientist takes when he adds to human knowledge is slow, painstaking, and unbiased. The practical experience in research, often disillusioning to the student for want of steadfastness, discipline, and perserverence, none the less helps him judge the efforts of others with understanding, and assists him in the erection of a standard as a gauge for the adequacy of his own future efforts.

THERE is recorded, as an addendum to this report, a list of the projects undertaken by the two physiology classes subjected to this method of teaching. Abstracts of a number of the "original experiments" follow.

Some of them display refreshing ingenuity. A number contain the germ of an idea worthy of further study. One or two hint at information of some practical importance. They are, however, presented with considerable hesitancy, lest they be taken as completed researches. The idea and mode of attack are of importance, rather than the data accumulated. It is to be remembered that they were performed by undergraduate students and that the actual period of experimentation was limited to a few weeks of study. The conclusions reached must be only tentatively accepted because of the paucity of the evidence substantiating them, and because the interpretation of this evidence is inevitably colored by the abandon of a relatively elementary student giving meaning to his first creative experimental effort.

Because the undergraduate student does not possess restrained and erudite judgment, criticism may be leveled at this project method of teaching. Does this experience distort perspective and give the student false ideas concerning the value of his contribution? This may be so. Much rests upon the counsel of the teacher. A careful preliminary training of the student in the principles of scientific method along the lines suggested in the body of this paper almost totally obviates this undesirable reaction. The enthusiastic speculations of the awakened student may outstrip the limits of his experimental evidence, but the benefits derived from the total experience seem to exceed the temporary risks occasioned by his immaturity.

ADDENDUM

I. THE TITLES OF ORIGINAL EXPERIMENTS PERFORMED IN APPLIED PHYSIOLOGY, FROM THE LABORATORY OF PHYSICAL EDUCATION PHYSIOLOGY, UNIVERSITY OF WISCONSIN

1. An inquiry into the effects of massage on the circulatory system.
2. A study of the amount of work done during and the time of recovery after ten maximal hops.
3. The effects of conditioning on cardiovascular efficiency.
4. A study of the sway of the body as influenced by means of auditory distractions.
5. A determination of the circulatory fitness of university women by Campbell's test.
6. The effect of hot baths on auditory acuity.
7. The effect of fatigue on the incidence of post-exercise albuminuria.
8. A graphic study of the foot relationships in dancing step patterns.
9. The effect of music on the ability to do work.
10. The effect of various types of muscular activity on the acidity of the gastric secretion.
11. A comparison of the fatigue resulting from walking in high and low heels.
12. A study of the post-exercise trough in pulse rate as found in physi-

cal education students, athletic college women, and non-athletic college women.

13. A study of the effect of psychic disturbances upon fatigue as shown by the amount of work done.

14. To determine the influence of fatigue upon foot strength and to study the difference in foot strength in athletic and non-athletic girls.

15. The effect of muscular work upon auditory acuity.

16. The effect of tobacco smoking on the steadiness of the hand.

17. To determine by means of oxygen consumption the more economical method of stair climbing; the two methods under consideration being the "correct" and the "incorrect" methods as taught in kinesiology and gymnastic therapeutics.

18. To study the cardiovascular efficiency of athletic and non-athletic tobacco smokers and abstainers.

19. The effect of experimental alkalosis on post-exercise albuminuria.

20. Respiratory changes during smoking.

21. The effect of exercise with accompanying mental fatigue on the mental ability as tested by complex reaction time.

22. To determine whether tall, thin people or short, stocky people are better fit to engage in exercise of speed or exercise of endurance.

23. To determine the immediate effects of tobacco smoking on the respirations of novices subjected to exercise on a bicycle ergometer.

24. The effect of drinking large quantities of water upon auditory acuity, visual acuity, and reaction time.

25. A schematographic study of animal mechanics.

26. The effect of exercise on the respiratory rate, respiratory rhythm, respiratory amplitude, and the pulse rate of athletic tobacco smokers and abstainers.

27. To determine the reactions of the cardiovascular system to a cold shower following exercise.

28. To study the efficiency of the cardiovascular system of the preadolescent, adolescent, and post-adolescent subject as indicated by the rate of recovery following light exercise.

29. A comparison of the postural variations in the blood pressure of physical education students with the changes in an active and in a sedentary group of co-eds.

30. Cardiovascular effects of tournament tennis.

31. The influence of athletic participation on vital capacity.

32. A study of the effect of coca-cola on habitual and occasional drinkers of caffein beverages with regard to blood pressure and pulse rate.

33. To study the changes in blood pressure and pulse rate following the consumption of a standard meal.

34. A study of the effect of exercise upon the white blood cell count.

35. The correlation of physical fitness with the incidence of post-exercise albuminuria in high school girls.

36. A study of the effect of coffee upon the central nervous system as evidenced by variations in auditory acuity.

37. To determine the best type of build for endurance running events.

38. To compare the blood pressure and pulse rate of physical education students with that of athletic and non-athletic college girls to determine whether training makes the heart respond more efficiently to changes in body position and to exercise.

39. To study the effect upon sleep of eating prior to retiring.

40. A study of the effect of coffee drinking on the cardiovascular system under varying conditions of fitness.

41. To study the relationship of recovery time to the amount of work done.

42. To study the immediate effect of tobacco smoking on the speed of turning a hand drill and on the speed of finger movements in discriminating reaction to a visual series.

43. To study and compare the increase in heart rate and time of recovery after swimming a sixty-foot dash and running an equal distance.

II. ABSTRACTS OF STUDIES PRESENTED AS ORIGINAL EXPERIMENTS IN APPLIED PHYSIOLOGY

1. A STUDY OF THE RELATIONSHIP OF PHYSICAL FITNESS TO POST-EXERCISE ALBUMINURIA IN HIGH SCHOOL GIRLS

By Margaret Anne Fosse

PHYSICAL fitness may be measured by the ability of the circulatory system to readjust itself to exercise. Many such tests of fitness have been devised. One of the most widely used is the Schneider Test. Rating by this test takes into consideration the level of the reclining pulse rate, the standing pulse rate, the acceleration in heart rate due to the assumption of the vertical position, the postural change in systolic pressure, the increase in pulse rate after a standard exercise, and the time of recovery to the pre-exercise normal. The highest score obtainable is eighteen, and the average score for high school girls is fourteen, according to the work of Dawson. A score below nine is indicative of a poor physical condition.

Albuminuria unassociated with disease is relatively common during adolescence. It was found to occur frequently after exercise in the particular group of girls studied. This observation led to speculation concerning its possible dependence upon general well-being and physical fitness. An experiment was therefore performed to determine whether physical fitness as judged by the Schneider Test is related to the incidence and to the severity of the albuminuria associated with participation in a basketball game.

Thirty-one high school girls were studied. These subjects were healthy and normal, most of them coming from country homes. They varied in age from thirteen to nineteen years and engaged in two one-hour periods of physical education a week. The following are the average results of the Schneider Test as given to this group:

Lying P. R.	71/min.
Standing P. R.	81/min.
Post-exercise P. R.	103/min.
Recovery time	72 sec.
Lying B. P.	101 mm Hg.
Standing B. P.	110 mm Hg.
Score	14

Urine samples were collected before and after regular class periods devoted to playing basketball. The subjects were grouped according to the severity of the muscular work done, and were classified as having performed mild, moderate, severe, or competitive exercise. The urine samples were tested quantitatively for albumin, using the sulphosalicylic acid method of Kingsbury, Clark, Williams, and Post.

Only traces of albumin occurred following mild and moderate exercise. Larger quantities appeared after severe exercise and the largest amounts after competitive exertion, the maximum quantity being 88mg./100 cc. urine. The average Schneider score for the entire group was 14. Of the 31 students acting as subjects, 9 equalled the group mean Schneider score and had an average of 10 mg. of albumin per 100 cc. of urine. There were 13 with scores better than the average. In this group, superior as to fitness, the average quantity of albumin found in the urine after exercise was 5 mg./100 cc. Nine students had scores below the mean and they showed a marked increase in the post-exercise quantity of albumin, the average amount being 40 mg./100 cc. The conclusion may therefore be reached, that an inverse relation exists between the amount of albumin in the urine after exercise and the physical fitness, appreciably larger quantities of albumin escaping into the urine of the less fit girl.

2. THE EFFECT OF FATIGUE ON POST-EXERCISE ALBUMINURIA

By Mildred Zaugg

CONSIDERABLE research on the problem of post-exercise albuminuria has been carried on, but its etiology is still obscure. While studying the literature on this subject, it was noted that fatigue as a possible cause of post-exercise albuminuria was not frequently mentioned. However, it was incidentally observed while performing another experiment, that when a subject was fatigued or out of condition, there seemed to be more albumin in the urine after exercise than when the subject was more fit. This was found to be especially true when the subject participated in strenuous exercise necessitating good endurance, such as competitive basketball and swimming. The purpose of this study was, therefore, to deter-

mine the relationship between post-exercise albuminuria and chronic fatigue experimentally induced by unhealthy living.

Two normal, healthy, young women acted as subjects. For one week they slept for about six hours a night, ate sweet and rich foods between meals, and daily exercised to excess. For the next two weeks the subjects got eight hours or more of sleep a night, ate hygienically, and exercised as moderately as compatible with their professional physical education routine. They reported to the laboratory during the last five days of each regimen and fitness was determined by the Schneider Test. A standard exercise was then performed on the electro-dynamic brake bicycle ergometer and the post-exercise albumin was quantitatively determined by the sulphosalicylic acid method. The exercise consisted of a short, very violent bout of work, carried on at high speed and known to induce albuminuria.

Subject E. L. had a Schneider score of 9 during the period of chronic fatigue and the standard exercise produced on the average 24 mg. of albumin per 100 cc. of urine. The healthy living increased her Schneider score to 10.4, a 15 per cent improvement, and the albuminuria fell to an average of 13.8 mg./100 cc., 42 per cent less albumin occuring in the urine than during the unhealthy experimental regimen.

Subject M. Z. had the very low Schneider score of 5.4 during the period of chronic fatigue and exercise produced on the average the following quantity of albumin, 45 mg./100 cc. Healthy living raised her Schneider score to 9.4, a 74 per cent improvement, and decreased the post-exercise albuminuria by 66 per cent to 15 mg./100 cc.

From these observations it may be concluded that an inverse relation seems to exist between the Schneider score and the output of post-exercise albumin, and that chronic fatigue is associated with a concomitant decrease in cardiovascular efficiency and an increase in the amount of albumin found in the urine after a standard bout of exercise.

3. THE INFLUENCE OF EXPERIMENTAL ALKALOSIS UPON POST-EXERCISE ALBUMINURIA

By Dorothy Thomas

THE cause of albuminuria is thought by some to be related to the acid-base balance of the blood, acidosis changing the diffusibility of the blood colloid so that more protein passes through the walls of the kidney. Violent exercise is known to be associated with an increase in the H-ion concentration of the blood and a lowering of the pH, these changes being reflected in the urine. It seemed, therefore, that alkalinization before exercise might prevent the occurence of post-exercise albuminuria. A simple method of producing experimental alkalosis is deep breathing, the over-ventilation washing out carbonic acid from the blood.

The subject came to the laboratory, voided, and rested quietly for fif-

teen minutes. A urine sample was then collected. The subject did a short violent piece of muscular work, riding the electro-dynamic brake bicycle ergometer for four minutes at an average pedalling rate of ninety-five revolutions per minute. Fifteen minutes after the collection of the first urine sample, the second one was obtained. These were tested quantitatively for albumin by the sulphosalicylic acid method and the H-ion concentration was determined electrometrically, using the quinhydrone electrode.

The second phase of the experiment consisted of a repetition of the above procedure, except that during the fifteen pre-exercise minutes, the subject voluntarily induced hyperventilation, increasing both the rate and depth of breathing.

The normal H-ion concentration of the urine was 6.52 and only faint traces of albumin were present, averaging 2 mg./100 cc. After exercise the H-ion concentration fell to an average of 5.99 and 73 mg. of albumin appeared per 100 cc. of urine. Deep breathing raised the pre-exercise H-ion concentration of the urine to 7.88 and after the exercise, in spite of its violence, the H-ion concentration of the urine was still on the alkaline side of neutrality, averaging 7.35. The post-exercise albuminuria was reduced in quantity from an average of 73 to 21 mg./100 cc., after one ergometer ride, only 3 mg./100 cc. occuring in the urine. The evidences, therefore, seem to indicate that albuminuria is related to the acid-base balance of the blood.

4. AN INQUIRY INTO THE EFFECTS OF MASSAGE ON THE CIRCULATORY SYSTEM

By Katharine S. Trumbull

IT HAS long been supposed and believed that massage has definite effects on the circulatory system. An examination of the literature shows that the trend of opinion is the same and that a consideration of the mechanics of circulation gives weight to the empirical proofs of practical workers in the field. Actual evidence, however, is notoriously contradictory. Because of the conflicting nature of the experimental data presented in the literature the purpose of this study was to acquire further facts concerning the effect of massage upon the heart rate and the blood pressure.

The same type and sequence of massage performed by the same masseuse upon a given subject may be assumed to produce similar results providing that the subject be in the same general condition and that she be stabilized in the position in which the massage is to be administered before beginning each experimental procedure. Both the effects of general massage and of the individual strokes were studied. The subject assumed the recumbent position lying prone, and after cardiovascular stabilization had occured, massage of the back was administered. Heart rate and blood

pressure readings were obtained at thirty-second intervals during the entire period of massage and were continued after its cessation until the cardiovascular system returned to the pre-massage level of activity.

General massage was found to be associated with a transitory fall in blood pressure occuring during the manipulation, the blood pressure rapidly returning to normal after the termination of the treatment. The pulse-rate results were variable, and seemed to be related to the level of the stabilized heart rate, causing it to vary in an inverse direction. Light stroking was without physiological effect upon the circulation. Deep effleurage produced an initial rise in heart rate, the blood pressure remaining unchanged. During petrissage a concomitant fall of blood pressure occurred, the heart rate accelerating and then falling to a level below normal. The results with circular friction, curled fingers, closed fingers, rain drops, and vibration were conflicting. As a whole, when consistent changes did occur, their magnitude was too slight to attribute physiological significance to them.

5. A STUDY OF THE EFFECT OF EXERCISE UPON THE LEUKOCYTE COUNT

By Rubye H. Tepper

SEVERAL investigators have found that exercise produces an increase in the number of leukocytes in the peripheral blood vessels. Schultz attributes this change to an increased activity of circulation which carries to the periphery white blood corpuscles which have been at rest in the great veins. In 1903, Blake noted a leukocytosis after marathon running which varied from 14,200 to 27,700. The purpose of this experiment was to study exhaustive exercise of short duration upon the leukocytic count.

The subject sat quietly in a chair for twenty minutes, and then blood was obtained. The subject then jumped rope as fast and as long as possible. The number of jumps and the duration of exercise were recorded. Immediately after the exercise, blood was again obtained and the number of leukocytes per known volume of blood was counted.

Exercise of 46.5 seconds duration, consisting of rope jumping at a rate of 2.15 jumps/second was followed by an increase in white blood cells equal to 83.11 per cent. The results indicate that even very short bouts of severe exercise produce an increase in the number of white blood corpuscles circulating in the peripheral blood stream.

6. REACTIONS OF THE CARDIOVASCULAR SYSTEM TO COLD SHOWERS AFTER EXERCISE

By Myrtle Pitzner

LITTLE work has been done on the effect of cold showers upon the recovery of the cardiovascular system after exercise. A cold shower first causes the blood vessels to contract, then to dilate and return blood to the skin. A normal, healthy subject was chosen for the experiment. After

cardiovascular stabilization had occurred, the blood pressure and pulse rate were taken with the subject standing in a shower where the exercise was to be performed. A 15.25 kilogram weight was lifted to a standard height for 3 minutes at the rate of 15 times per minute. At the termination of the exercise, the blood pressure and pulse rate were taken every 30 seconds until complete recovery occurred. Upon another day the procedure was repeated with the exception that immediately upon cessation of the exercise, the cold shower was turned on for 35 seconds, after which the blood pressure and heart rate readings commenced.

The exercise produced an increase in systolic pressure of forty-seven mm. Hg., an increase in diastolic pressure of eight mm. Hg., and an increase in pulse rate of twenty beats per minute. It took eight minutes for the cardiovascular system to return to the pre-exercise level. When a brief cold shower followed immediately upon the cessation of exercise, the maximal systolic pressure increase recorded was twelve mm. Hg., the diastolic pressure fell four mm. Hg., and the pulse rate accelerated thirty-six beats per minute. The blood pressure rapidly returned to normal, recovery being complete in two minutes as compared with eight minutes when the exercise was not followed by a shower. Although the cold shower increased the heart rate, it returned to normal with great rapidity, recovery being complete in one minute.

The results of this experiment indicate that a cold shower hastens the return of the cardiovascular system to normal after exercise.

7. TO DETERMINE BY OXYGEN CONSUMPTION THE MORE ECONOMICAL OF TWO METHODS OF STAIR CLIMBING

By Martha L. Konz

FROM our knowledge of body mechanics we know that, by and large, most natural activities are performed in a manner which is easiest and least costly in terms of energy expenditure. Theoretically the correct method of stair climbing consists in placing the *whole foot* on the stair tread and getting a definite lift with the extension of the ankle and a push off with the toes. Observation shows, however, that although young children learning to climb stairs use this mode of progression, few adults do so. The customary adult method of stair climbing is limited to the use of the ball of the foot, the heel at no time being in contact with the stair, the movement of the limbs being similar to that employed in running.

To determine which of the two types is more economical, the metabolic rate was measured by oxygen consumption. A modified Benedict-Sanborn basal metabolism machine supplied with a large blower was placed at the foot of a stairway and arranged so that the fullest range of movement was allowed by the rubber tubing. This permitted the subject to walk up and down six steps. The subject was carefully instructed as to what he was expected to do and stood at the foot of the stairway until cardiovascular

stabilization occurred. The nose clip was then adjusted, the mouth piece inserted, and the subject was connected with the oxygen tank. The oxygen consumption in the erect posture was determined. A metronome was set to control the rhythm of the stair climbing and the subject made eight ascents and descents of the six stairs. At the completion of the exercise the subject remained standing for two minutes and the recovery metabolic rate was determined. The entire procedure was once repeated, climbing first correctly and then incorrectly. All of the subjects were physical education students who had had previous instruction in the art of stair climbing, both in kinesiology and in gymnastic therapeutics. None of them, however, were habitual users of the so-called correct method.

In all cases the heat production on mounting the stairs in the correct way was less than in the ordinary incorrect method habitually used. The average heat production was 47.9 per cent less than that on incorrect climbing, the range varying from 17.5 to 113.8 per cent. Furthermore, the average recovery was 72.9 per cent better in the first minute after the exertion and 3 per cent better in the second minute. The results therefore show that the theoretically correct method of stair climbing is the most economical in terms of energy expenditure, requiring a smaller increase in energy and being followed by a more rapid recovery than the incorrect method habitually used by the subjects.

8. COMPARISON OF THE FATIGUE RESULTING FROM WALKING IN HIGH AND LOW HEELS

By Marion Broer

MANY of the Wisconsin co-eds wear high heels continually on the Hill. Some of them contend that they become more tired after walking the Hill in low heels, others holding the opposite view. An experiment was therefore planned to determine whether high or low heels are more fatiguing, or if the resultant fatigue depends upon which heel one is most accustomed to wearing.

Three subjects were selected, one habitually wearing high heels, one accustomed to low heels, and the third wearing both with about equal frequency. The subjects were given Crampton's blood ptosis test and Campbell's test of cardiovascular efficiency to determine their fitness and were found to be similar in their reactions.

The University of Wisconsin campus is ideal for the standard walk selected. The pulse rate was taken. The walking started on Park Street at the foot of the Hill, continued up the Hill to the Engineering Building in one minute, to Bascom Hall in two minutes and fifteen seconds, down the Hill and past the Biology Building in three minutes, ending at the base of the Hill at Lathrop Hall in four minutes. In Lathrop Hall the recovery pulse rate was followed until the pre-exercise level was again attained. Each subject twice performed the walk in high and twice in low heels.

The trend of the reaction was the same in all three subjects. A composite of their findings shows that the pulse rate acceleration was 20.9 beats per minute greater after the high heel walk than after the low and that the recovery took 5 minutes longer. The fall in the pulse rate was rapid during the first 2 minutes, then more gradual, dropping to a level below normal and then recovering to the pre-exercise rate. The negative phase was shallow and transitory, but did not occur after the low-heel walk. The average pulse rate acceleration after the high-heel walk was 67.78 beats per minute, an 83 per cent increase, that after the low-heel walk being 46.88 beats per minute, an increase of 57 per cent. The average high-heel walk recovery time was 13 minutes and 15 seconds, the low-heel walk recovery occurring in 8 minutes 15 seconds.

Since the pulse rate rises to a greater height after a walk in high heels than after the same walk in low heels, and since it takes longer to recover after a walk in high heels than the same walk in low heels, we may conclude that it is less fatiguing to walk in low than in high heels regardless of which one is accustomed to.

9. TO DETERMINE THE DIFFERENCE IN FOOT STRENGTH BETWEEN ATHLETIC AND NON-ATHLETIC GIRLS

By Beth Wines

MUCH of athletic ability is dependent upon a good foot and most sports involve the use of the lower extremities. Flat foot is a common deformity thought to be aided by exercise. Because time did not permit the study of the influence of therapeutic exercise upon the strength of such a foot, indirect evidence of its effect was obtained by a comparison of the foot strength of girls who do and who do not participate in general exercise, limiting the observations to the inverters of the foot which are most frequently weakened. The principle of the test was that of Martin. The subject tightened the inverters of the foot. The foot was then forced into a position of eversion, the power of resistance measuring the strength of the inverters.

The subject placed her foot into a shoe skate adjusted by a strap to avoid slippage. The weight was distributed as evenly as possible on both feet and on signal, the inverters were strongly contracted to resist an eversion produced by a lever attached to the runner of the skate. Power was applied through a spring scale with a sliding indicator. The subject signalled the operator as soon as she felt she could no longer resist the pronating influence of the lever. At this breaking point the observer registered the pounds pull and corrected the reading for the mechanical advantage of leverage. The highest of three trials was taken.

Thirty-five subjects were studied: 15 physical education majors and 20 non-majors. The average foot strength of the physical education students was 96.32 lbs., that of the non-majors being 72.1 lbs. The physical

education students were all accustomed to wearing low-heel sport shoes. Of the regular college girls, only 3 habitually wore low heels, 14 wore cuban heels, and 3 constantly wore high heels.

An interesting incidental observation was made upon one subject who wears comparatively high heels at all times and who had had trouble with fallen arches. To determine the result of fatigue upon her foot strength, she walked three flights of steps with one skate and one high-heel shoe on. After the exercise there was a 66 per cent decrease in the power of the inverters to resist the pronating pull of the lever.

The results of this study indicate that the foot strength is greater in girls who participate in physical activity and in girls who habitually wear low heels on their shoes.

10. TOBACCO SMOKING AND ITS EFFECT ON CARDIOVASCULAR EFFICIENCY

By Dorothy Claas and Elsie Popp

ATHLETES believe that the heart of a tobacco smoker is less efficient in periods of strain than the heart of an abstainer. Most coaches prohibit the use of tobacco during training. We had so often heard the idea expressed, "Oh, it makes no difference whether I smoke or not," that we decided to experiment. The purpose of this study was to determine the cardiovascular efficiency of habitual tobacco smokers and compare the findings with those obtained on total abstainers.

The subjects were subdivided into four groups, first as smokers and non-smokers, then as sedentary or athletic in their habits of exercise. The Schneider Test was used to measure cardiovascular efficiency.

The non-athletic tobacco smoker had the lowest Schneider score, averaging 9, which falls at the lowest limit of normal. The tobacco smokers accustomed to participation in athletics had a slightly higher score, averaging 10. The sedentary abstainers had an average Schneider score of 12.33, while the athletic abstainers ranked highest with an average score of 15.33.

These evidences suggest that participation in physical exercise tends to improve cardiovascular efficiency and that tobacco smoking brings about an impairment in fitness, the lowest efficiency scores being obtained by sedentary smokers.

11. THE IMMEDIATE EFFECT OF SMOKING ON MOTOR SKILL

By Marjorie Hamer

THE effect of smoking on the physiological condition of the body is one of great interest. Many and varied have been the experiments conducted concerning this problem and correspondingly varied have been the conclusions drawn. Most experiments show, however, that even in hardened smokers, when once nicotine reaches the nerve cells, it affects all of them and through them the various organs and bodily processes. The

primary effect of nicotine is one of stimulation to the nerves followed by depression, the action taking place through the autonomic and sympathetic ganglia.

The purpose of this experiment was to determine the immediate effects of tobacco smoking on motor skill. Two of the six tests of Seashore's Motor Skills Unit were used in this investigation. These were the Miles motility rotor for testing speed in turning a small hand drill and the serial discriminator for testing speed of finger movements in discriminating reaction to a visual series.

Each subject was first given the serial discriminator test, and then immediately took the Miles motility rotor test. After these two tests, the subjects smoked three cigarettes, one after another in rapid succession. The motor skill tests were then again repeated. The experiment was performed upon smokers and non-smokers.

In all cases after smoking results were better than the before-smoking ones. In the serial discriminator test the average appeared higher both before and after smoking in the habituated subjects than in the abstainers. The smokers' improvement in time was 9.25 seconds and that of the non-smokers was 9.5 seconds, being approximately equal, showing that the difference in the effect of tobacco smoking in this group of habitués and abstainers was negligible. The smoking improved the number of turns made with the hand drill, increasing from 189.5 to 209 in the smoker and from 214.75 to 218.95 in the abstainer.

We may conclude from these observations that the immediate effect of smoking is to increase motor efficiency.

12. THE EFFECT OF MUSIC ON THE ABILITY TO DO WORK

By Billie C. Wood

MANY forms of muscular exercise are performed to the accompaniment of music. It is known that the emotional excitement induced by the playing of a band at a game may considerably heighten the power and ability of the contestant. The purpose of this experiment was to measure the effect of music on the ability to do work.

The subjects were all university students, twelve being especially trained in rhythm, ten of them dance majors, one a pianist, and one a violinist. Thirteen were average college women without special music or rhythm training. That music was to be played while working was unknown to all of the subjects and the apparatus was so arranged that a victrola record could be started and stopped by remote control.

The power to do work was measured with a Mosso finger ergograph. The subject was blindfolded and asked to pull as long and as hard as possible. When a fatigue curve appeared, the experimenter turned on the victrola, the record played being the "Anvil Chorus" by Tannhauser. The music was stopped after a period determined by the operator, depending

upon the fatigue of the subject, and the ergogram was further continued for a time equivalent to that during which the music was played. Ergograms were made by a capillary pen writing with ink upon the kymographion paper. From the record of the lift and the load, work done was calculated.

Of the 25 subjects studied, 4 showed a loss in power when the music was played, only one of the group belonging to those specially trained in music and rhythm. There was an increase in the power to do work in the remaining 21—it being 140 per cent greater in the musically trained group. In 7 cases the ability to do work remained higher than that of the period preceding the music even after the stimulus was withdrawn. We may conclude that, in most cases, music increases the ability to do work and that the subject especially trained in rhythm and music shows a greater augmentation in muscular power than the untrained person.

13. EFFECTS OF CONDITIONING ON CARDIOVASCULAR EFFICIENCY

By Elizabeth Morrison

OWING to the paucity of material it would appear that very little investigation has been made of the effect of conditioning on cardiovascular efficiency. The evidences in the few studies available are conflicting and no decision on the merits of training and the detrimental effects of poor condition can be made. The purpose of this study was to determine the effects of unhygienic health habits upon the cardiovascular efficiency.

For three days and nights the subject slept for four hours or less per diem and partook of an irregularly administered and poorly chosen dietary. For six days immediately following this regimen, good health habits were instituted, consisting of nine hours of sleep a night, an hour of rest after luncheon, and a dietary of simple and nourishing foods. The first three days of this period allowed for recovery from the poor regimen.

The subject came to the laboratory daily and performed Crampton's blood ptosis test which is supposedly influenced by changes in physical condition. A weight-lifting test of cardiovascular efficiency was also performed, 5.5 kilos being lifted a distance of 49 centimeters at a rate of 60 lifts in 2 minutes.

By Crampton's formula the cardiovascular efficiency was greater during the regular health-habit period than during the unhygienic regimen, the efficiency being 80 per cent and 71.3 per cent respectively. The weight-lifting test showed a significant difference in the post-exercise recovery. If a shorter period of recovery means a greater cardiovascular efficiency, the subject was in a much better condition during the regular health habit period, the average recovery time being about half that of the unhygienic regimen. The results tend to show that infractions of the ordinary rules of healthy living are associated with an impairment in physical fitness as measured by cardiovascular efficiency.

An Analysis of the Errors in Stop-Watch Timing

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and
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STATEMENT OF THE PROBLEM

DURING the past few years there has been increasing disapproval of the method ordinarily used to time a championship sprint race. There is also considerable doubt as to the exact accuracy[1] and reliability[2] of many of the listed world's records. A preliminary report on the results of this study was eagerly sought and published by the Associated Press[3] because of the increasing sensitiveness of the sport's public to the significance of small errors in timing. A runner at the finish of the 100-yard dash in good competition is running at a speed of better than 30 feet per second. At this rate the significance of a small error of 1/10th of a second is equal to 3 feet. A judge who could not distinguish between runners 3 feet apart would be considered exceedingly poor. It may only be explained through a lack of appreciation of the problem that errors of the magnitude of 1/5th to 2/5ths of a second are permitted under the present system of hand stop-watch timing. *Upon the nature and magnitude of these errors in stop-watch timing would seem to depend the future of all electrical timing devices designed to time sprint races.*

That there is a definite movement to supplant the present crude methods of hand timing in important record events is well evidenced, first because of the sudden greatly increased interest in the patents for electrical timing devices and those operating on the photo-timing principle; and, second, in the practical fact that many sport followers have witnessed experimental timers in operation at some of the more important

[1] By "accuracy" is meant true reproduction in magnitude.
[2] By "reliability" is meant consistency of performance.
[3] Alan J. Gould, "Inaccuracies of the Hand that Holds the Stop Watch Strikingly Demonstrated by Laboratory Research at the International Y.M.C.A. College, Springfield, Mass." Associated Press Dispatch, all principal papers in U.S., July 16, 1931. Experiments by T. K. Cureton and D. E. Coe.

meets. For a number of years electrical apparatus and different types of chronometers have been used in the experimental laboratory to determine small time intervals with great precision.

In the field of athletics the Lobner Sports Timers[4] were among the first operated successfully. These were experimentally demonstrated at the 1928 Olympics and have been used in most of the important races in Europe including foot-racing, horse and motor car races as well as bob sled races. In 1929 Kenneth Crookes[5] developed a photo-electric timer for track events at Ohio State University. About this time the kymograph-vibrating tuning fork method was adapted to time track races at Springfield College in the Department of Applied Physics. The writer assigned to Lyle Welser, research student in the same department, the problem of constructing a timer operating upon the principle of a solenoid actuating a lever which in turn started a stop watch. This method has proved very satisfactory as a relatively simple and inexpensive method. Welser[6] has described this in a separate writing. Charles H. Gustavus visited Springfield in August, 1931, and presented evidence that he had invented a photo race time recorder which was the same in principle as that developed by Kirby.[7] This is described briefly in an excellent general article by Kirby which explains in detail the difficulties with human timing. The paper is deficient only in quantitative results which show how much stop-watch timing varies with electrical timing. At the 1932 Olympic games the Kirby Two-Eyed Camera as developed by the Bell Laboratories was used very successfully, this method being the official method of deciding disputes in judging and a supplementary method of timing. C. H. Fetter[8] has described the apparatus and method in the *Bell Telephone Quarterly*. The Kirby Two-Eyed Camera photographs the finish and the dial of an accurate clock simultaneously. The International Amateur Athletic Federation has approved electrical timing and has recommended that hundredth-second timing be adopted as the world standard.

The purpose of this study is to present the findings of a series of experiments which were begun in 1929 and have continued over a period of two and a half years on the nature and magnitude of the errors involved in timing a sprint running race. It may be pointed out that while the work done has principally involved sprint running races, the results may be subject to broader interpretation since identical problems are en-

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[4] F. L. Lobner, clock manufacturer, Berlin W 9, Potsdamer Str. 23.

[5] Kenneth Crookes, Photo-Electric Timer for Track Events, thesis, Ohio State University, 1929.

[6] Lyle Welser, "A Practical Electro-Mechanical Race Timer," Physics Department, International Y.M.C.A. College, Springfield, Mass., 1931.

[7] Gustavus T. Kirby, "On the Problem of Timing Races," *I.C.A.A.A.A. bulletin*, No. 17 (Nov. 4, 1931).

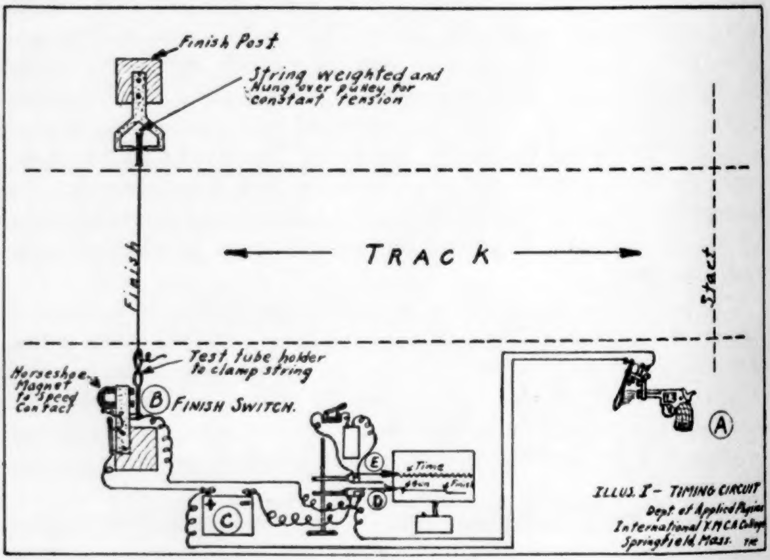
[8] C. H. Fetter, "A New Way of Splitting Seconds," *Bell Tel. Quarterly* (Oct. 1932).

countered in acoustics and in all situations in which timing is done by means of a stop watch.

THE METHOD

The experimental method used consisted of using an electrical circuit and a vibrating tuning fork to time the race. The actual race situation was reproduced using the regular start and finish. One series of results were obtained under competitive meet conditions. The times obtained were compared with the times from the stop watches held by human timers. Rumberger[9] reported a series of experiments on the error made in using stop watches to time events of short duration but employed the artificial laboratory stimulus-response method. In this work a great deal of attention was given to the perfection of an electrical circuit which would unquestionably measure the race to an accuracy of 1/100th of a second. However, in attempting to make something of an experimental analysis of the error, the finger-on-watch reaction time delay was tested in the laboratory. Sight stimulus and sound stimulus were used and the major portion of the data obtained by direct reaction to the starter's gun.

The circuit to time the race consisted of the special gun switch (A) which was operated by the blast from the starter's gun, the finish switch designed by Welser (B) which was actuated by the runner striking the finish string, the line battery (C), and the signal marker (D). These were



ILLUS. I – TIMING CIRCUIT
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[9] E. K. Rumberger, "The Accuracy of Timing with a Stop Watch," quoted in *Readings in Experimental Psychology,* W. L. Valentine, Harper Bros., N.Y., 1931, pp. 18–20 (adapted from *Jour. of Exp. Psy.*, 1927, vol. 10, pp. 60–61).

wired so that the starting signal would be received through a circuit made up of the starting switch, the line battery, and the signal marker. As the gun fired, the circuit was completed causing the armature of the signal marker to be pulled down and then to be instantly released. The blast of the gun made the contact but as soon as this was over a spring caused the contact to be broken. This switch was made so that it would "make and break," thus releasing the line wires for the finish signal. When the runner reached the finish string, the finish signal was obtained through the circuit including the finish switch (B), the line battery (C), and the signal marker (D). The electrically vibrated tuning fork (E) was vibrated continually during the race on a specially made large drum which would take the entire race (Illustration I).

The timing record obtained was of the form shown in Illustration II.

The top line was traced by the signal marker and this shows the starting and finishing signals of the race. The middle tracing was made by the tuning fork vibrating at the rate of 100 vibrations per second. The lower tracing was made by the Jaquet chronometer showing the time intervals in fifths of a second. In this sample the electrical time was 4.54 sec. as determined by counting the vibrations and the time as reported by the timers was (1) LaRue 4.5 sec., (2) Johnson 4.4 sec., and (3) Thompson 4.3 sec.

The checking of many intervals showed that the tuning fork was vibrating twenty times in each fifth of a second which verified the rate of 100 vibrations per second. The possibility of a plus or minus variation of 1/200th of a second was granted because of the difficulty of judging just where the vibrations began and where they stopped. By having the countings checked by independent observers, however, this was reduced. There seemed to be no doubt as to the accuracy and consistency of the tuning fork vibrations. It was found that clearer vibrations were obtained by building a large drum 12 inches in diameter and increasing the speed of the kymograph.

The finish switch was so constructed that the maximum amount of movement of the string was less than an inch before the switch operated the signal marker. The accuracy of such an arrangement in terms of time can be demonstrated by a simple calculation. Assuming the rate of the runner crossing the finish line to be 30 feet per second, it would take .00278 sec. to move the string through the inch to make contact. This was compensated for by mounting the switch one inch closer to the starting mark. This corrected the error due to the give of the string. The switch had the special feature of having a horseshoe magnet placed so as to draw the contact bar attached to the string as quickly as possible. It required only a slight force to operate the switch. The hinge of the contact bar was made so as to permit a minimum of friction.

The signal marker was the object of greatest suspicion due to the fact that the reluctance of any magnetic circuit as caused by the current traversing a coil wound around an iron core is known to cause a time lag in the current thus delaying it in building up to the value required to operate the armature of the electro-magnet. In other words, when the gun fired, it was suspected that the signal marker did not operate instantaneously. This factor might have been one affecting the sensitivity of the circuit to a degree that would have made it an important factor if it could not be shown that it was negligible, or if present, just how it varied with the gun contact and the finish contact. Consequently, a study was made of this factor. The windings of the core were rearranged so as to convert the signal marker into a vibrator. It was demonstrated that the signal marker was sufficiently sensitive enough to move down and up in a time not greater than .013 sec. Since the building up of the magnetic flux and its deterioration also occurred in this time as well as the entire movement acting to overcome the inertia in the armature, it was safe to say that the delay on a single signal (the mark being scaled at the very first of the downward movement) was certainly only a fraction of this total, possibly in the neighborhood of .003 sec.

In a personal communication with Mr. Kirby is the following statement:

> "In the slow motion pictures which we have taken of the hammer of a pistol used by us, an exposure of less than 1/250th of a second shows in one picture the hammer of a pistol definitely up and in the next picture, the hammer is fully down, with smoke in the same frame......... we have also found that the electronic lamp flash was recorded in the same identical frame."

Over ordinary electrical circuits the current travels very fast, approximately with the speed of light or about 186,000 miles per second. It is only when there is special reluctance present that the speed is diminished. Only because the circuit used in this experiment contained the coil in the signal marker was a calibration deemed essential. It was also certain that the starting signal was given simultaneously with the blast because the shield was placed directly in front of the muzzle of the gun.

It may be pointed out that while the electro-magnetic lag[10] (time to energize the coil and move the armature) was present at the start, it was also present at the finish and compensated. It seems safe to say that the circuit was satisfactory to time intervals as small as 1/100th of a second.

Using the same laboratory signal marker, a similar gun switch, and a similar circuit, a specially designed switch was constructed to test the finger-on-watch reaction delay.

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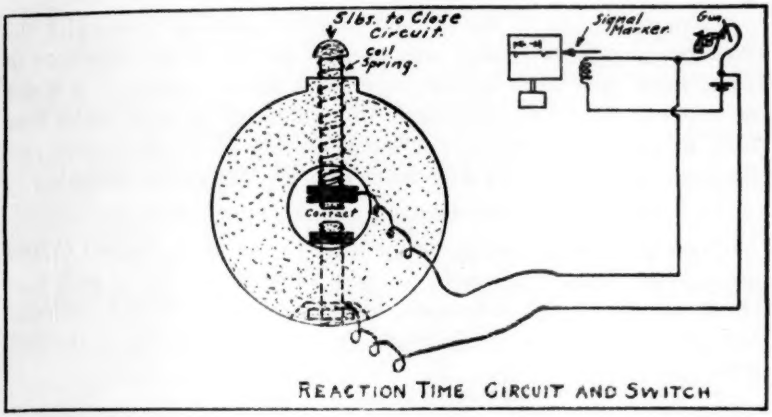
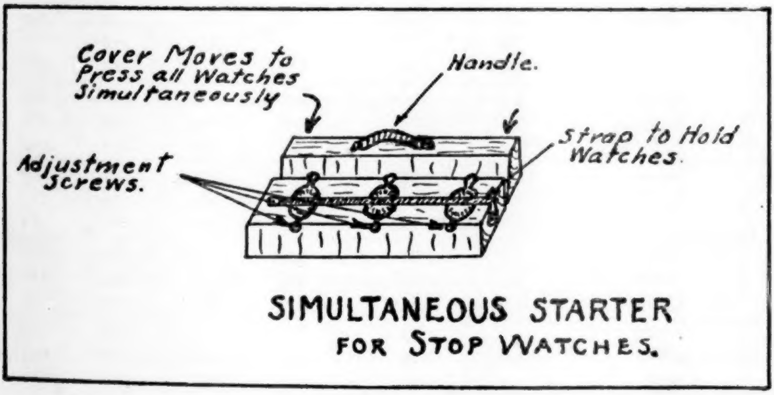
[10] See F. F. Fowle, *A. I. E. E. Handbook*, 5th ed., New York: McGraw-Hill Book Co., 1922, pp. 347–351. $t = -\frac{L}{R} \log_e \left(1 - \frac{Ri}{E}\right)$.



ILLUS. III

Illustration III shows this switch.

Realizing that reaction time delay of this type is not only neurological in nature, i.e., depending upon the speed of perception and the rate of propagation of the nerve impulse, but is partly mechanical as modified by the resistance to be overcome and the leverage governing the force to overcome the resistance, this was taken into account in designing the switch. The switch was built in a shape corresponding to the shape of the watch so that it could be held in the same position in the hand as the watch. A spring was inserted on the plunger corresponding to the stem of the watch which had approximately the same resistance to pushing the stem. The gun was fired and as soon as possible afterward the subject pushed the switch.



ILLUS. IV

Tests were taken on the subjects who had acted as timers with this apparatus. Visual perception was stressed as this is the type used in timing races. One series of tests were taken in the laboratory in which the subjects reacted to the movement of a stylus. Another series were taken in which the subjects reacted to the gun as in the regular race situation. Additional tests were made over the full racing distance.

DATA ON SPRINT RACES OF DIFFERENT LENGTHS

The apparatus was set up on the indoor track at Springfield College and a series of nine races were run with three timers timing each race. The timers were tested to determine their reaction time to sight stimulus. In each race the timers were instructed to start their watches on the flash of the gun.

TABLE I (Time in seconds)

DATA FROM TIMING 30-YARD SPRINTS

Trials	Timers	Stop-Watch Time	Electrical Time	d	Reaction Time: Fore-finger	Thumb	Average
	LaRue	4.5	4.54	—.04	.200	.300	.250
1	Johnson	4.4	4.54	—.014	.215	.220	.217
	Thompson	4.3	4.54	—.24	.162	.155	.158
	Deane	4.25	4.43	—.18	.215	.130	.172
2	Jones	4.15	4.43	—.28	.235	.230	.232
	Barnes	4.15	4.43	—.28	.200	.235	.217
	Dogherty	4.5	4.86	—.36	.215	.260	.237
3	Cairns	4.6	4.86	—.26			
	Peabody	4.4	4.86	—.46	.346	.140	.243
	Torosian	4.4	4.63	—.23	.190	.190	.190
4	Norton	4.4	4.63	—.23	.150	.140	.145
	Patterson	4.2	4.63	—.43	.210	.180	.195
	Orozco	4.6	4.735	—.135	.220	.240	.230
5	Mantell	4.9	4.735		.240	.215	
	Cureton	4.6	4.735	—.135	.195	.220	.207
	Irvine	4.4	5.00	—.60	.230	.255	.242
6	Jackson	4.5	5.00	—.50	.295	.230	.262
	Relyea	4.6	5.00	—.40	.160	.205	.182
	Hughes	4.5	4.725	—.225	.200	.185	.192
7	Babiar	4.6	4.725	—.125	.175	.255	.215
	Treu	4.7	4.725	—.025	.195	.170	.182
	Smith	4.6	4.645	—.045	.180	.215	.197
8	Saffer	4.5	4.645	—.145	.230	.195	.212
	Linton	4.6	4.645	—.045	.217	.210	.213
	Silvia	4.6	4.75	—.15	.225	.275	.250
9	Elder	4.6	4.75	—.15	.220	.170	.195
	Abel	4.5	4.75	—.25	.180	.220	.200
				Av. —.228	.211	.208	.209

In the table above the reaction times given are the average of two

trials on the thumb and the average of two trials on the forefinger. The watches used in these trials were 1/10th second Meylan timers and were in agreement over a 60-second interval. Illustration IV shows the device made to start and stop three watches simultaneously.

In the following trials the timers were instructed to start their watches on the flash or the smoke if they could not see the flash.

TABLE II

DATA TAKEN FROM 100-YARD SPRINT RACES ON THE OUTDOOR TRACK

Trial	(Time in Seconds) Electric Time	Stop-Watch Time		Deviation
1	12.47	11.4	(Saffer)	— 1.07
2	11.83	11.55	(Seutching)	— .28
3	12.94	12.5	(Kaminsky)	— .44
4	12.01	11.9	(Crucius)	— .11
		12.0	(Elder)	— .01
5	12.86	12.3	(Hall)	— .56
		12.4	(Doyle)	— .46
6	11.95	11.7	(Stranton)	— .25
7	13.865	13.4	(Doyle)	— .465
		13.6	(Hubbard)	— .265
		13.0	(Welser)	— .865
8	13.19	12.8	(Hubbard)	— .39
		12.6	(Doyle)	— .59
		13.0	(Welser)	— .19
9	12.09	11.4	(Phillips)	— .69
		11.8	(Patterson)	— .29
		11.9	(Welser)	— .19
10	12.435	12.2	(Townsend)	— .235
		12.1	(Patterson)	— .335
		12.1	(Welser)	— .335
11	13.75	13.4	(Townsend)	— .35
		13.4	(Stanton)	— .35
		13.4	(Welser)	— .35
12	13.05	12.8	(Townsend)	— .25
		12.8	(Stanton)	— .25
		12.8	(Welser)	— .25
13	15.02	15.0	(Townsend)	— .02
		14.8	(Stanton)	— .22
		14.8	(Welser)	— .22
14	14.38	14.2	(Townsend)	— .18
		14.2	(Stanton)	— .18
		14.0	(Welser)	— .38
				Av. — .345

In a track meet between Springfield and New York University School of Education the following results were obtained:

TABLE III (Time in seconds)
DATA FROM AN OFFICIAL TRACK MEET

Event	Electrical Time	Stop-Watch Time (sec.)		Deviation (sec.)
Hurdles 120-Yd.	17.23	17.1	(Blumenstock)	—.13
		16.8	(Phillips)	—.43
		16.8	(Bickford)	—.43
100-Yd. Dash	10.57	10.2	(Blumenstock)	—.37
		10.2	(Phillips)	—.37
		10.3	(Bickford)	—.27
				Av. —.333

The timers were stationed 100 yards away from the gun and by using the reaction time switch a comparison was made between the reaction to the smoke signal and the reaction to the sound signal. In the latter case the timers were instructed when to be ready but were not permitted to watch the gun.

TABLE IV (Time in seconds)
DATA FROM COMPARING SMOKE AND SOUND AS THE STARTING SIGNAL FOR THE TIMERS

Timers	.22 Calibre Gun		.32 Calibre Gun		.22 Gun vs. .32 Gun	
	Smoke	Sound	Smoke	Sound	Smoke	Sound
W. T.	.38	.62	.26	.49	—.12	—.13
L. K.	.38	.51	.27	.46	—.12	—.05
G. B.	.36	.49	.27	.49	—.11	.00
W. P.	.23	.47	.27	.44	+.04	—.03
C. N.	.24	.51	.12	.46	—.12	—.05
A. K.	.22	.40	.17	.39	—.05	—.01
Av.	.301	.500	.226	.455	—.075	—.045

The day of these trials was an extremely bright sunny day. Of the six men tested, one thought that he could detect the flash, the others could not.

CONCLUSIONS

In the series of runs over 30 yards at top speed the average over-all error was —.228 sec. with a range of —.014 sec. to —.600 sec. *All of these errors by 26 different timers were in the same direction,* i.e., the stop-watch time was faster than the electrical time. At an average rate of 30 ft./sec. the poorest timer would have made an error of —.600 sec. or an error equivalent to 18 feet. The best timer would have made an error equivalent to 5 inches. The average error would have been equivalent to 6.84 feet.

In the series of 100-yard runs arranged for the experiment, 32 timers made an average over-all error of —.345 sec. with a range of —.01 to —1.07 sec. The average error was equivalent to 10.35 feet. The greatest error was equivalent to 32.1 feet.

In the two races timed in the official N.Y.U.-Springfield track meet the average error of six timers was — .333 sec., with a range of error from — .13 to — .43 sec. The smallest error would have been equivalent to 3.9 feet and the largest 12.9 feet with the average error 9.99 feet.

TABLE V

SUMMARY OF THE OVER-ALL ERROR

Distance of Run	Number of Timers	Average Error (sec.)	Range of Error (sec.)	Av. Equivalent Error in Feet
30 yds.	26	— .228	— .014 to — .60	6.84
100 yds.	32	— .345	— .01 to — 1.07	10.35
100 yds. (official meet)	6	— .333	— .13 to — .43	9.99
	64	Av. — .302	— .01 to — 1.07	Av. 9.06

The summary in Table V shows that the average over-all error as made by 64 timers was — .302, an error equivalent to 9.06 feet in timing short sprints.

Comparative Reaction to Smoke and Sound with .22 and .32 Calibre Guns.—Only one of six men tested was certain that he could see the flash of the .22 calibre gun 100 yards away. The average reaction delay to the smoke stimulus was .301 sec. and to the sound stimulus .500 sec. These reactions were shortened when the larger .32 calibre gun was used. The reaction delays were than .226 sec. for smoke and .455 sec. for sound. This meant that the larger gun caused a finger-on-watch reaction faster by .075 sec. for smoke and .045 sec. for sound.

The Relationship of Finger-on-Watch Reaction Delay to the Total Error.—A study of the data in Table I shows that a considerable portion of the total error in timing is due to the finger-on-watch reaction delay to the starting signal as represented by the flash or smoke of the gun. Graph I shows the total error plotted and also the corresponding reaction time delay curve. It is easy to see from this curve that in the majority of cases there is a strong relationship between the total error and reaction time. For instance, subjects Peabody, Irvine, and Jackson had three of the slowest reaction times and also have the three greatest errors. On the other hand, Deane, Treu, and Elder have three of the shortest reaction times and their errors are also relatively small. It is evident, however, that other factors sometimes becloud this relationship. The guess at the finish as to when it is time to push the watch is undoubtedly very variable. The correlation between total error and reaction time delay was + .305 ± .122. Considering all of the factors which might have pulled down the magnitude of this correlation, it may be regarded as a significant coefficient.

DISCUSSION

The results of these experiments are logical and, with respect to magnitude, squarely within the range of what should have been found. A comparison of the finger-on-watch reactions with the findings of the experimental psychologists is shown in the table below:

TABLE VI

COMPARATIVE RESULTS ON REACTIONS[11]

	Reaction to Sound	Reaction to Light
Wells, Kelley, and Murphy	.204	.237
Richet	.149	.197
Dockeray and Isaacs	.155	.197
Cureton and Coe (6 timers)	.194*	.226
(25 timers)		.209

Table IV gives some data which serves as a check upon the sensitivity of the circuit used and also upon the general accuracy of the results. The average reaction of 6 subjects to the smoke signal from the .32 calibre gun was .226 sec. The average reaction of the same six subjects to the sound signal was .455 sec. It would be expected that ordinarily the sound reaction would be faster. The results of the experimenters above (Table VI) show that the average reaction to sound stimulus was .169 sec. and to light stimulus .210 sec., sound being faster than light by .041 sec. By adding this difference to .455 sec. the figure .500 is obtained. The rate of travel of sound should equal,

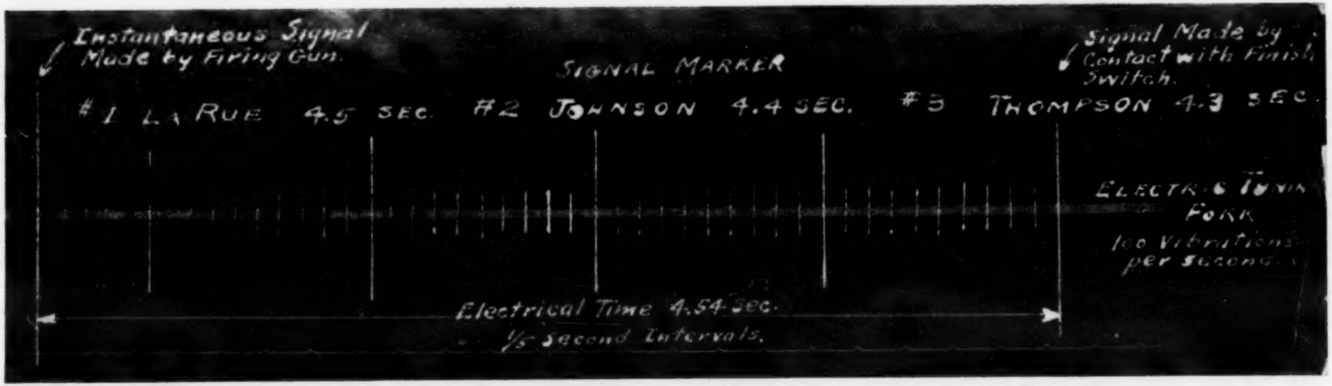
$$\text{Velocity} = \frac{300 \text{ feet}}{.500\text{-}.226 \text{ sec.}} = \frac{300}{.274} = 1095 \text{ ft./sec.}$$

The Smithsonian Physical Tables quote the rate of travel of explosive waves in air for a charge of powder weighing .24 gms. as 1102 ft./sec. In the .32 calibre cartridge there was a charge of powder weighing .541 gms. By interpolating and correcting for temperature (25° C.) a value of 1147.5 ft./sec. was obtained for sound to travel 300 feet under the conditions of the experiment. For this computation the .32 calibre results were used because there was evidence that the greatest majority of the men could not see the flash from the .22 calibre gun. This computation resulting in 1095 ft./sec. for the rate of travel of sound is a verification of the rate of travel of the explosive wave within 4.5 per cent.

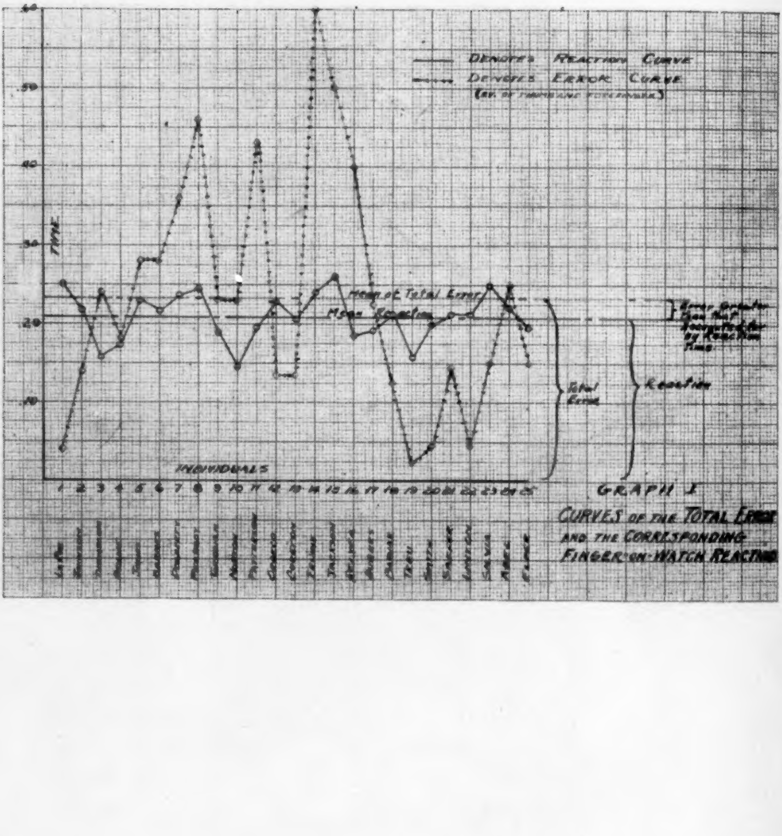
Timers Tend to Anticipate the Finish.—The average total error of 64 times in timing short sprints was —.302 sec. The average reaction of 25 of these to sight stimulus was .209 sec. The reaction delay does not

[11] W. L. Valentine, *Readings in Experimental Psychology,* New York: Harper Bros., 1931 and F. L. Wells, C. M. Kelley, and Gardner Murphy "Comparative Simple Reactions to Light and Sound," *Journal Exp. Psy.,* 1921, v. 4, pp. 57–62.

* Obtained by correcting the average sound reaction (.455 sec.) for the time required for sound to travel 100 yds. at 1147 ft./sec.



ILLUS. II—Electrical timing of a race.
Department of Applied Physics, Springfield College



GRAPH I

CURVES OF THE TOTAL ERROR AND THE CORRESPONDING FINGER-ON-WATCH REACTION

account for the total error in timing. There is a difference of .093 sec. in direction which would have been accounted for by the timers anticipating the finish and stopping their watches too soon. Graph I shows this relationship.

In one test a certain timer was "framed" to stop his watch early. In this group of timers every one was found to have anticipated the finish as indicated by the usually large errors when compared with the electrical time. Possibly minimal queues of movement or the watch sounds caused an early reaction. This illustrates the important point that human timers should be separated if possible. Dunlap [12] mentions the variations which may be produced by a varying stimulus, such as, a runner rapidly nearing the tape:

"When the reactor attempts to make his reaction synchronous with the stimulus pattern........the reaction may precede or follow with a positive or negative error varying from a few sigma to 30 sigma [13]."

To stop the watch just when the runner crosses the tape is almost a physical impossibility when the runner is travelling as fast as 30 feet per second. In the laboratory a large drum was revolved with black letters as large as 6″ x 6″ marked clearly on a white background. These could not be distinguished from one another when the peripheral speed of the drum became greater than 20 feet per second when the observer was 15 feet away. This shows that there is actually a physical limitation to the speed of sight and that this undoubtedly varies among observers.

In this connection a general principle related to timing and judging may be stated which is frequently violated. The closer the timer or judge stands to the track, the faster the runner will appear to cross his field of vision because the distance included within the visual angle is less than when the observer is farther away. A train several blocks away may appear to be moving fast but when the observer is only a few feet from the the train, it rushes by so that almost nothing can be distinguished. Likewise, a judge or timer is in a more advantageous position when he is located 20 or 30 feet back from the track than when crowded up close to the edge. When farther away the whole field can be included in the visual angle, otherwise a shift of gaze is necessary.

Intensity of the Stimulus.—The results obtained show that the larger gun with a larger flash produced a quicker reaction. Ladd [14] points out, as have numerous other investigators, that the reaction time varies inversely with the magnitude of the stimulus. Wundt and Froeberg [15] have

[12] Knight Dunlap, see *Science*, vol. 57: 538–9 (May 11, 1923).
[13] Sigma = .001 sec.
[14] George T. Ladd, see *Psychology*, William James, vol. 1, Henry Holt & Co., 1890, p. 95.
[15] Sven Froeberg, "The Relation Between the Magnitude of the Stimulus and the Time of Reaction," *Columbia Contributions to Philosophy and Psychology*, vol. XVI, No. 4, No. 8 (Dec. 1907), New York: Science Press.

shown that a greater stimulus produces a faster reaction. Abroad it is more common to use larger guns to start races. If it is desirable to time upon the flash, as is now the rule, it would seem logical to have a large calibre cartridge charged with powder of super-flash quality and a gun with a relatively short barrel so that the flash would be visable for a longer period. It would be helpful to have more research upon the color of the flash and the best background for optimum visual acuity. Kirby makes an interesting statement regarding the relative accuracy of timing upon the flash as compared with the smoke:

> "Our slow motion pictures have shown the flash and the smoke (that is, the smoke right at the muzzle of the gun and not the large cloud of smoke that is observed several feet therefrom) are within 1/250th of a second."

It is the opinion of the writer after observing the quantitative results of many timers with respect to accuracy that few, if any, get the smoke which appears simultaneous with the flash but time the puff of smoke which appears several feet from the barrel. In the case of distraction so that the timer starts his watch on the sound, an error is introduced of approximately .261 sec. for 100 yards and .556 sec. for 220 yards. These errors are equivalent to 7.83 feet and 16.68 feet, respectively, due to sound requiring time to travel the distance.

"Novices" vs. "Experts."—It would not seem reasonable for a timer, whether expert or novice, to have an error in timing smaller than the smallest physiological reaction possible in a human being. In testing 25 timers the smallest reaction was .145 sec. This is equivalent to an error of 4.35 feet approximately in a 100-yard dash. This figure also agrees with those from other experiments. How it is possible for a human timer to time correctly is a question because it would seem to depend upon the timer pushing his watch after the runner had actually crossed the finish tape the distance which would compensate for the late starting of the watch on the gun. Yet it is reputed that expert timers compensate in some way, for instance, Mr. Kirby comments that,

> "Had the timers in your experiment been Dieges, Bishop, and Hatfield instead of LaRue, Johnson, and Thompson (see Illus. II), the electrical time and the human time represented on the graph would probably have been as close as 4.54 and 4.50 seconds. The trouble with manual timing is that there are very few efficient timers, and second, there are fewer still properly regulated, accurately recording watches."

In a personal communication with Professor Reilly, Associate Professor of Physics at McGill University, he makes the following comment:

> "I have upon many occasions acted as timekeeper at track meets and in the majority of them I have been very much dissatisfied with the results obtained. It has been my experience to be associated on timing committees with individuals who should never have been asked to act as timekeepers. There have been instances in the past in which I have withdrawn my name from the timing committee, owing to the fact that I realized that some of the members of such committee were not qualified to measure the time required for a 100-yard dash, or for any race.

"This same question has been brought forcibly to my attention in experimental work upon acoustics, in which it was necessary to measure by means of a stop watch short periods of about two seconds in length. I maintain that such a system of making determinations is unreliable. I have been more or less alone in my stand, since it was pointed out that it was possible for me to obtain the same result as that obtained by others by what is referred to by the laboratory student as 'cooking.' I maintained that timekeepers introduce errors from 5 per cent to 10 per cent in magnitude when using a stop watch. In my own mind I believe that only those individuals who have spent time in making scientific measurements with a high degree of precision should be chosen to act in the capacity of timekeeper on occasions such as those to which you and I and some others have been giving serious thought."

On the other hand, in support of Mr. Kirby's statement that some timers are remarkably accurate, the official times at the Olympics may be compared with the time as recorded by the Kirby Two-Eyed Camera. These were reported by C. H. Fetter: [16]

Run	*Official Time*	*Camera Time*	*Deviation*
100 m.	10.3	10.38	+.08
100 m. hurdle	14.6	14.57	—.03
200 m.	21.2	21.12	—.08
400 m.	46.2	46.28	+.08
400 m. hurdle	51.8	51.67	—.13
800 m.	1:49.8	1:49.7	—.10

These results show that accurate timing is ***possible,*** that is, provided the accuracy of the Kirby Two-Eyed Camera is beyond reproach. The results of the precision study made on this method are not available in print as yet. It is interesting to note that two of the timers had plus errors, whereas, ***in this study every timer had a minus error.***

Evidence that all timers vary may be easily collected. Every timer will vary in a series of reaction time trials to some extent even though he be familiar with the errors of timing. This is typified by two cases in which the magnitude of these variations is given:

Name	*No. Trials*	*Mean*	*a. d.*	*A. D.*	*Range a. d.*
Coe (forefinger)	13	—.210	±.0354	±.0098	.170
Coe (thumb)	13	—.234	±.0439	±.0122	.160
Cureton (forefinger)	9	—.199	±.023	±.0077	.090
Cureton (thumb)	9	—.199	±.0236	±.0078	.080

This table shows that the deviations in the case of two men varied from .08 to .170 sec.

It has been shown by Breitwieser [17] that the resistance to be overcome modifies the reaction time. This is very variable in watches. Tests on only a few watches have shown variations from 1 to 10 pounds. The position in the hand changes the leverage and modifies the force and speed of the reaction. Woodrow [18] demonstrated that a preparatory warning signal of

[16] C. H. Fetter, *op. cit.*
[17] J. V. Breitwieser, "Attention and Movement in Reaction Time," *Archives of Psychology,* Columbia Univ., Science Press, (Aug. 1911).
[18] Herbert Woodrow, "The Effect of Variation of the Preparatory Interval on Reaction Time," see W. L. Valentine, *op. cit.,* p. 183.

approximately 2 seconds was best to get the optimum response. This is variable in track events. Evans [19] has shown that distractions interfere with the speed of reaction. Sullivan [20] has shown that mood even governs performance. Wenner and Taylor [21] have shown the effect of the blood condition on reflex time. Rumberger [22] has also shown that skilled and unskilled timers are not very different in the range of their reaction variations by using 435 observations on seven experts and four unskilled timers:

	Av. of Lowest Times	*Av. of Highest Times*
Skilled Timers	.084	.196
Unskilled Timers	.082	.261

These facts would indicate that all timers are subject to variations and that the inexperienced are apt to make errors almost as great as the experts in a series of trials upon the same person.

The Accuracy of Stop Watches.—The accuracy of the watch itself is an important matter. The cheaper stop watches are stopped by a plunger striking a pinion but due to the fact that some inertia is present, the hand may creep a tenth or even a fifth of a second. This is particularly likely in case the watch is dirty on the contact surfaces of this stopping mechanism. This creeping error would compensate in the direction of making the total error less when compared with electrical timing. The more expensive watches eliminate this to some extent. It has been impossible to get much accurate information about the calibration of stop watches from the manufacturers, probably because there may be a danger of hurting sales. Mr. Kirby has spoken of having six standard I. C. A. A. A. A. 1/10th second timers tested in various positions and at different degrees of winding. The oscillograph records of these tests should prove interesting.

SUMMARY AND FINAL STATEMENT

1. The errors involved in stop-watch timing are of great importance in timing sprint races in track, swimming, and other short speed events, such as the rope climb; they are also of consequence in acoustic laboratory tests and in all situations where the stop watch is used to measure small intervals of time. The middle watch of three may not be as accurate as either of the extreme watches. Because of these inaccuracies many of the existing world's records are subject to suspicion and the sporting public is becoming increasingly sensitive to these discrepancies. In sports the matter of timing has caused many disputes and bad feelings over records.

[19] John E. Evans, "The Effect of Distraction on Reaction Time," *Arch. of Psy.*, Columbia Univ., No. 37, (Dec. 1916).

[20] Elizabeth T. Sullivan, "Mood in Relationship to Performance," *Arch. of Psy.*, Columbia Univ., No. 53, (May, 1922).

[21] W. W. Wenner and A. B. Taylor, "The Changes in Acid Base Equilibrium on Reflex Time," *Amer. Jour. Phys.*, vol. 91, No. 2 (Jan. 1931), 365–369.

[22] E. K. Rumberger, *op. cit.*

2. The method used for timing short sprint races as used in this experiment is validated in a precision study to warrant its use in this experiment. The schemes of the starting switch and the finish switch were developed in the Physics Laboratory, Springfield College.

3. The errors found in stop-watch timing are of such magnitude as to cause grave concern. Sixty-four timers made an average error of —.302 sec. in timing short sprints, including the 100-yard dash. This error is equivalent to 9.06 feet in good competitive circles. The error was always in the same direction, i.e., the stop-watch time being faster than the electrical time.

4. The analysis of the error showed the greatest part due to the reaction delay in starting the watch, on the basis of average results 87.8 per cent of the total error being due to this cause. Various eccentricities, such as guessing at the finish and the inaccuracy of the watch itself, contributed to 12.2 per cent of the error. A correlation of $+ .305 \pm .122$ P.E. was found to exist between the total error and the reaction delay.

5. The reaction to starting the watch is variable even in the best timers and is affected by the intensity of the stimulus, readiness of the observer, physiological condition, mechanical position of the watch in the hand, resistance of the watch stem to pushing, acuity of vision, experience, and other factors. The reaction to the .32 calibre gun was faster than to the .22 calibre gun. The flash could not be consistently seen at 100 or 220 yds.

6. Timers who expect to time by the stop-watch method should be better selected with consideration given not only to experience but to knowledge of the errors and a physiological capacity for a small error.

7. The results show the great necessity for a wider understanding of the problem by the layman and the encouragement of all types of mechanical, electrical, or photographic timers in various combinations. It seems to be a necessity that sooner or later all world's records should be certified by a non-human timer of certified accuracy by expert calibration in a physics department or engineering laboratory.

Studies in the Start of the Sprint

By W. W. Tuttle
State University of Iowa

DURING the past few years a number of experiments dealing with starting the sprint have been completed in the physiological laboratories of the State University of Iowa. These experiments have been carried out through the cooperation of a number of men under the direction of the writer and Coach George T. Bresnahan. The names under each topic heading refers to the individuals who conducted the experiment.

I. AN APPARATUS FOR MEASURING STARTING TIME IN FOOT RACES

By

W. W. Tuttle, *Department of Physiology*
George T. Bresnahan, *Track Coach*
State University of Iowa

AT THE present time there are a number of controversial points relative to the starting time in foot races. There are also a number of theories quite generally accepted as facts which apparently need investigation. In order to make an accurate scientific approach to some of these problems, an apparatus has been devised for measuring starting time. In view of the fact that we are investigating a number of problems by means of this apparatus it is described in detail here so that in future reports details of apparatus may be omitted.

Before attempting to measure starting time some consideration was given to the question of just what constituted starting time. The body makes four contacts with the track when in the "get-set" position. Although all these contacts are broken during the start, this does not occur simultaneously. It is the general rule, that in case of a right-handed man the sequence of breaking contact consists of first, lifting the left hand; second, lifting the right hand; third, driving off with the right foot; and fourth, driving off with the left (front) foot. It seems impractical to attempt to combine all these movements into one continuous effort represented by a time measure. This would probably mean that the start

would begin when the last contact with the ground was broken. Some might argue one thing and some another with regard to just what constitutes a start. However, it occurred to us that certainly a runner has commenced his start before all his ground contacts are broken. We do not wish to leave the impression that an attempt is being made to settle the question of what constitutes a start. It is necessary, however, if we are to investigate the question of starting to have some common basis from which to work. For this purpose we have defined starting time as consisting of the interval elapsing between the stimulus (gun shot) and the breaking of the supporting contact of the back foot. The apparatus for measuring starting time herein described is designed on the basis of this definition of starting time.

Before describing the apparatus which we have designed it should be

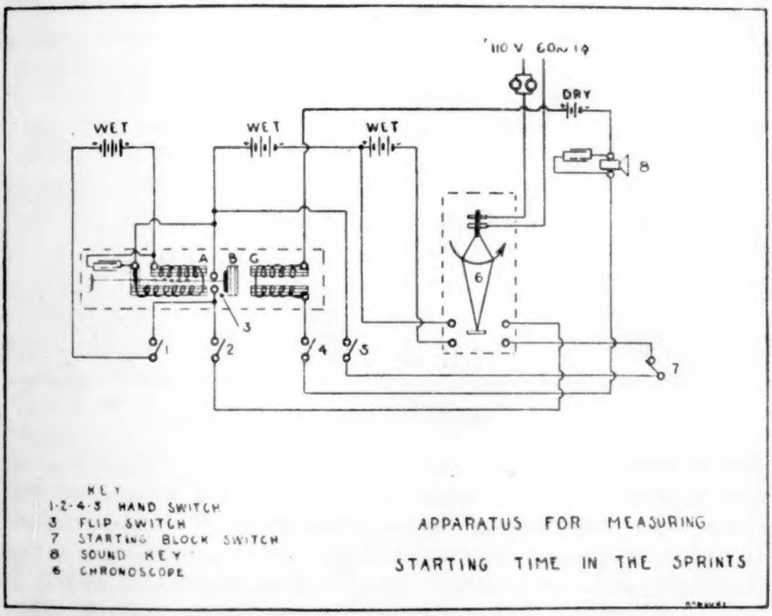


FIG. 1.—This is a detailed drawing of the electric circuits in the apparatus used for measuring the starting time of runners.

noted that an apparatus used for a similar purpose has been described by Nakamura[1]. The starting time as recognized by this investigator was the interval elapsing between an electrical trigger contact and the time when the hands were lifted from the track. It occurred to us that by actually recording the sound of the gun as the stimulus and the forward movement

[1]H. Nakamura, "An Experimental Study of Reaction Time in Starting Races," *Japan. J. Psychol.*, 1928, III: 231–262.

of the back foot as the start, conditions would be set up which were more nearly like the actual conditions under which sprinters are started.

The starting time is recorded by a standard Dunlap chronoscope[2], which is operated on a 110-volt, 60-cycle, single phase alternating current. Since the accuracy of the chronoscope motion depends on the constancy of the current oscillations, it is necessary to investigate this point. Information furnished at the power-house showed that the oscillation variation is never more than eight-tenths of one per cent. A further check by Travis and Young[3] shows that current variations in our laboratory are negligible. Since the chronoscope is equipped with a dial graduated for 60-cycle current, time is read directly in sigma (thousandths of a second).

In order to record the instant that the gun is fired a Dunlap sound key[4] is employed. Since the activation of a sound key of this type produces

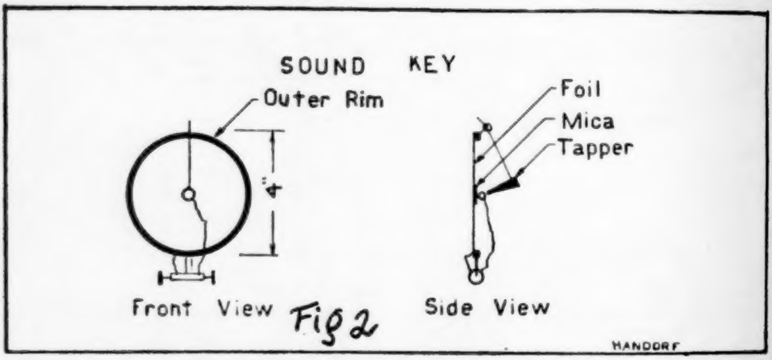


FIG. 2.—A detailed drawing of the sound key.

an instantaneous break and since a continuous make chronoscope circuit must be initiated and maintained, a double relay must be employed. This double relay consists of an ordinary telegraph relay with two magnets (C) (Fig. 1) mounted in front of the relay switch armature (B) so that the relay switch moves between the two sets of magnets (A and C). It must be remembered that a telegraph relay switch operates between two contacts, one insulated and the other of platinum. In this arrangement the insulated contact is on the C-magnet side. The sound key (8) is placed in series with two dry cells and magnets (C). The back magnet on the

[2]This is standard equipment which may be secured from C. H. Stoelting Co., Chicago, Ill.

[3]Lee E. Travis and C. W. Young, "The Relation of Electromyographically Measured Reflex Time in the Patellar and Achilles Reflexes to Certain Physical Measurements and Intelligence," *J. Gen. Psychol.*, 1930, III, 374–400.

[4]This apparatus is listed by C. H. Stoelting and Co., Chicago, Ill., as the Dunlap Voice Key, No. 17216. The arrangement of the key in the circuits is shown by (8) Fig. 1 and the details of the key are shown in Fig. 2.

chronoscope (6) is placed in series with a six-volt wet cell and switch (3). A spring is attached to the relay switch (B) which pulls it away from the sound key magnets (C) when they are demagnetized. The tension on the spring is so adjusted that it is just barely overcome by the magnets. It must be remembered that the sound key circuit is always closed except at the time the gun is fired. For this reason a single knife switch (4) is placed in this circuit. Now, when the gun is fired the sound key instantaneously breaks the circuit thus demagnetizing magnets (C). As this occurs, the spring pulls the relay switch (B) over, thus closing the chronoscope circuit at (3) and at the same time starting the dial hand. A single knife switch (2) is placed in this circuit. Here, however, another obstacle must be overcome. Some provision must be made for holding the relay switch (B) against contacts (3), otherwise as soon as the sound key makes the circuit after the gun shot the chronoscope circuit is again open due to the activation of magnets (C). In order to keep the chronoscope circuit closed at (3) the relay switch (B) must serve a dual purpose. The magnets (A) are placed in series with a 6-volt wet cell and the relay switch (3). Now, when the gun is fired, the sound key circuit is opened thus demagnetizing magnets (C). At this time the spring pulls the relay switch (B) over, closing the chronoscope circuit at (3) and at the same time the circuit going to magnets (A). A single knife switch (1)

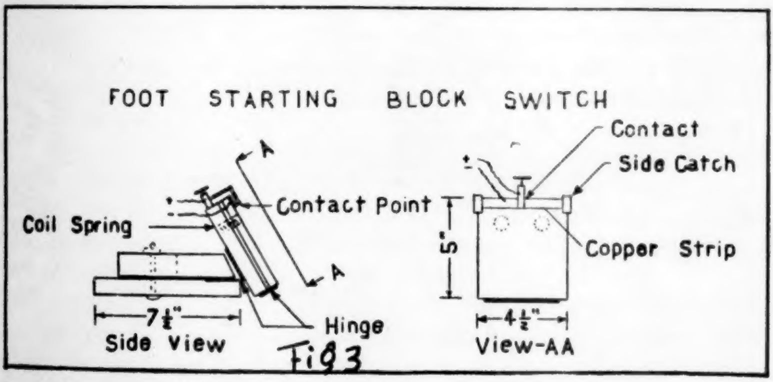
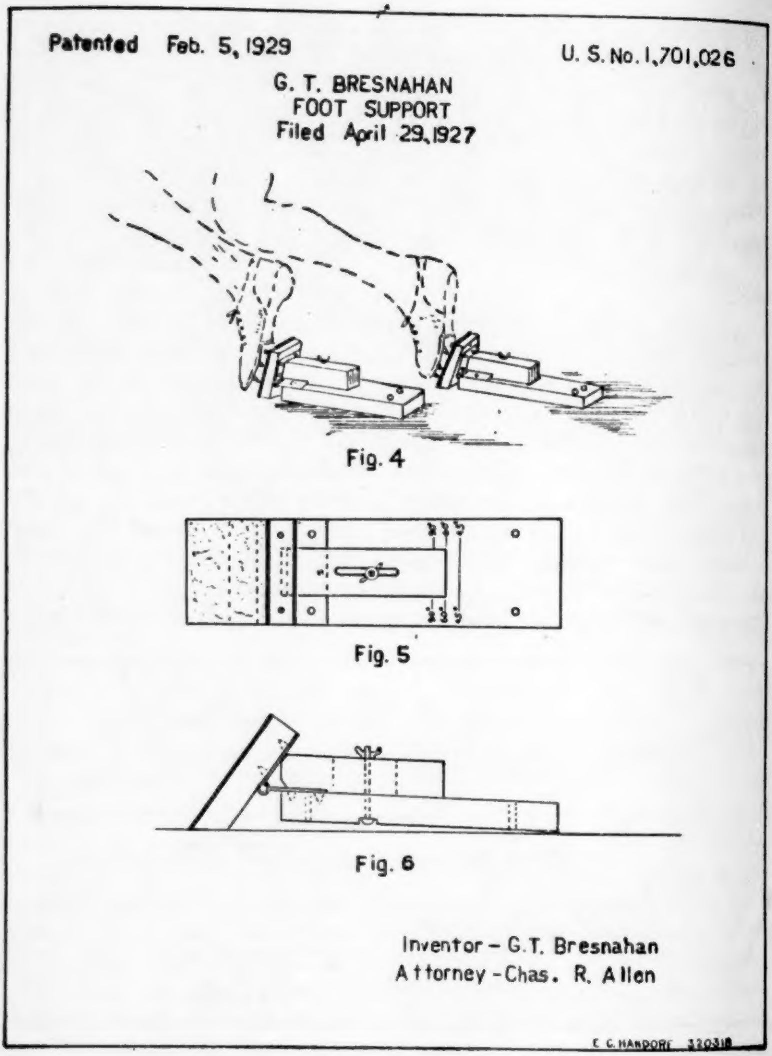


FIG. 3.—A detailed drawing of the modified starting blocks.

serves to open the circuit. With this arrangement of circuits, when the shot is fired, the back magnet on the chronoscope is activated, thus starting the dial hand. The hand continues to revolve until it is stopped by the activation of the front chronoscope magnet.

In order to record the start of a sprinter a starting block[5] is placed

[5]The place of the starting block in the circuit is shown by (7) Fig. 1. The details of the arrangement of the block are shown in Fig. 3. The blocks are shown in detail in Figs. 4, 5, and 6.



FIGS. 4, 5, and 6.—Detailed drawings of regular starting blocks.

in series with two 6-volt wet cells and the front chronoscope magnets. A thin board is hinged at the bottom of the starting block. Between the board and the face of the block two stiff springs are placed. A brass hook projects over the top of the block which makes contact with a brass strip at the top and on the face of the hinged board. Here again we have a closed circuit system. At the command "on your mark," the sprinter gets into position. At the command "get set," he raises into starting posi-

tion. As he comes to the starting position his weight against the hinged board opens the circuit by compressing the springs between the board and the face of the starting block. Since the springs between the board and the face of the starting block keep this circuit closed except when the sprinter is in the "get-set" position, a single knife switch (5) is placed in the circuit and is always kept open except at the command "get set." When the apparatus is not in use all knife circuit switches are open. In order to eliminate some of the "spark" a 5 M.F.D. condenser is placed in all three circuits.

When all is in readiness for a reading to be taken, the order of procedure is to first close the sound key switch (4). This opens both the chronoscope circuit and the circuit through magnets (A) when switch (1) is open and switch (2) is closed, since this procedure activates the sound key circuit magnets (C) thus pulling the relay key (B) away from contacts (3). Now the relay magnet circuit is put in readiness by closing switch (1). At the command "get set," the response circuit is open in two places (7) and (5). At this command the switch (5) is closed, the circuit being kept open by the weight of the sprinter against the hinged board on the face of the starting block. When the gun is fired, the sound key circuit is instantaneously broken, thus closing the chronoscope circuit and the relay magnet circuit. The relay magnet (A) keeps the chronoscope circuit closed by holding the switch (B) against contacts (3), and the dial hand continues to move until the sprinter leaves the starting block at which time the response circuit is closed and the dial hand stopped by the potential difference between the front and back chronoscope magnets.

There are two unbalanced circuits in the set-up. One of them is between the chronoscope magnets where the front magnet is in a 12-volt circuit and the back one in a 6-volt circuit. The other is between the sound key magnets (C) and the relay magnets (A) where (A) is in a 6-volt circuit and (C) in a 3.6-volt circuit.

As soon as the sprinter permits the closing of the response circuit by leaving the starting block (7), the dial hand stops and the reading is made. Immediately then the relay magnet circuit (A) is opened and closed by switch (1). This permits the sound key magnets to pull the relay switch (B) against magnets (C) thus breaking both the relay magnet circuit and the chronoscope circuit at (3) at the same time. Now the response circuit is opened by switch (5) and left open until the command "get set" is again given. Now the apparatus is set for another reading.

There are a number of errors which are introduced in the starting time by the apparatus. The chief source of these errors is the making and breaking of circuits. There is no way of eliminating this principle but the error can be reduced to a minimum by keeping the contacts bright and close together. Another source of error is the lag in the operation of

the magnets, especially where unbalanced magnetic fields are maintained. In order to reduce this to a minimum the voltage on the weak side is kept as small as is consistent with efficient work while on the strong side the voltage is great enough to be instantaneously effective. The lag in the spring which pulls the relay switch armature across must not be neglected. This is reduced to a minimum by making the tension of the spring just below the threshold of effectiveness of the relay magnets.

The sensitiveness of the sound key is worthy of note. Experiments show that a 22-caliber gun shot is effective within a radius of fifty feet of the sound key. It is activated by a cap pistol within a radius of three feet and the snap of the finger one foot away.

For the sake of uniformity the starter stands six feet behind and at the sprinter's left. The sound key is mounted on a tall stand and is placed at the same distance from the starter as the sprinter. The speed of sound and the sensitiveness of the sound key make a small variation in position negligible.

Although there is no reason why the apparatus cannot be transported to the regular track, it serves its purpose better if it is built up around an inside track specially constructed for experimental purposes. The recording device is placed inside a room out of sight and hearing distance of the sprinter and is connected to the stimulus-response apparatus by wire. The starting blocks are so constructed that they may be adjusted by the sprinter in the ordinary manner. The conditions on the track, so far as the sprinter is concerned, need be no different from those which he experiences in a regular race.

The problem of the sprinter "jumping the gun" is automatically taken care of by the apparatus. If the sprinter leaves his marks before the gun is fired, the front chronoscope magnet is activated. Since the voltage in the front magnet is much greater than in the back magnet, the chronoscope fails to move from zero even though the gun is fired.

Although there may be some argument and differences of opinion as to the absolute time which we are measuring, it seems reasonable to assume that, for purposes of investigation and making comparisons under controlled conditions, the technique and apparatus just described are adequate.

II. A COMPARISON OF THE STARTING TIME OF RUNNERS USING HOLES IN THE TRACK AND STARTING BLOCKS

By

THOMAS C. HAYDEN, *Director of Physical Education, Coe College*

and

GEORGE A. WALKER, *State University of Iowa*

IT IS very evident that a good start is essential in running a good race and every means must be taken into account in order to help a runner get the fastest possible start. This is especially true in the shorter races where every fraction of a second must be economized.

One of the most recent customs, which has been adopted by many coaches in order to aid a sprinter in getting started, is to place starting blocks on top of the track from which the runner leaves his marks. Naturally there has been some argument concerning this custom. There are those who contend that starting blocks are an advantage to a sprinter, while others feel that the blocks make no difference in the start so far as the sprinter is concerned. Those who have adopted starting blocks recognize the fact that they are an advantage in that the track is protected from holes and that adjustment is easier and quicker. It is further argued that starting blocks give a sprinter more confidence in his start, since he is less apt to lose his footing and balance when he starts from a firm surface on top of the track.

There is, no doubt, virtue on both sides of this question. However, it seems that the crucial question to be answered is—what is the difference in time consumed in leaving the marks by these two methods of starting? It is evident that, especially in the shorter races, any method which shortens starting time is, without question, a material advantage. If starting blocks shorten starting time in addition to lending more confidence to the sprinter in his start, then certainly everyone is ready to admit the advantage of starting blocks over holes in the track.

If starting blocks yield different starting times than holes in the track, then uniformity among sprinters in the same race is self-evident. Furthermore, on the same basis, records made from holes in the track are not comparable to those made from starting blocks.

In order to aid in settling the question of starting blocks versus holes in the track as methods of starting a race, the experiment herein reported has been carried out.

THE OBJECT OF THE EXPERIMENT

It is the purpose of this investigation to compare the starting time of sprinters using blocks with their starting time using holes in the track.

It is not the purpose of this investigation to defend either method but merely to present the facts as indicated by data gathered under controlled conditions.

DEFINITION OF STARTING TIME

The fact that there might be some confusion in deciding just what starting time actually is, is taken into account. There is some disagreement as to what constitutes a start and many times, on the basis of an illegal start, the matter rests with the individual starter of a meet. On the "get set" there are four points of contact with the track, all being broken at different times. In order to define starting time, about all one can do is select one event such as lifting the left hand, as constituting a start. Some might contend that a sprinter has not left his marks until his "front foot" has been removed from the mark. This is not a question for us to decide. However, for purposes of investigation and comparison, one can legitimately select some event in the sequence of events in the start as representing the start. As stated in a previous part of this paper,

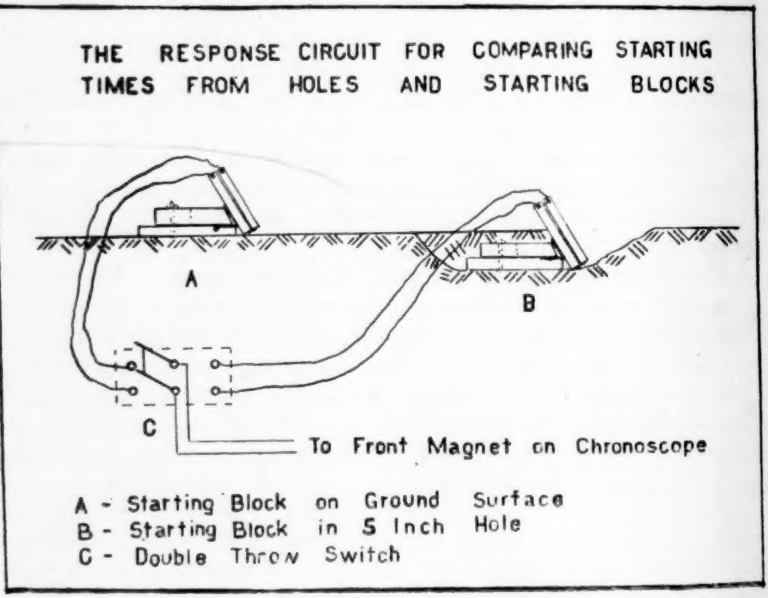


FIG. 7.—Details of the arrangement of the response circuit.

starting time is defined as the time elapsing between the stimulus (gun shot) and the instant the sprinter lifts his "back foot" from the starting block or the back of the hole in the track. On this assumption the data presented in this paper were collected.

REVIEW OF LITERATURE

A survey of the literature shows that it contains no reports of experimental data dealing with the problem under consideration in this investigation.

THE TECHNIQUE

The main features of the apparatus used for collecting the data reported here have been previously described. The only deviation from the original apparatus is in the response circuit. The response circuit used in this experiment is shown in Fig. 7. Since responses are to be recorded from both holes in the track and starting blocks on top of the track a double response circuit is provided. In order to do this a double-throw knife switch is placed in the response circuit. One pair of end terminals on the switch is connected to the starting blocks on top of the track and the other end terminals are connected with the apparatus placed in the holes in the track. Now when the starts are made from the blocks the switch is thrown in the direction of the blocks and when the holes are used it is thrown in their direction.

In order to record starting time from blocks on top of the track, blocks of the Bresnahan type are modified as described in the original apparatus to which reference has already been made. A modified block is placed in back and an ordinary block is placed in front. The sprinter arranges the blocks and fastens them to the track.

In order to record the starting time from holes in the track the holes are dug in the usual manner. In the back of the back hole a modified starting block is securely fastened. The hole is then filled with dirt around the block so that it has the ordinary appearance except for the block at its back (Fig. 7). It might be argued here that the starting block in the back of the hole might modify the results of the experiment. It occurs to us that if the block in the back of the hole modifies the situation at all it does so to the advantage of the sprinter, since the face of a starting block is certainly more solid than cinders. The holes are of the usual depth and are the same as the sprinter uses under competitive conditions.

Although the break switches are constructed so that the distance between contacts is very small, and is the same on all blocks, there might be some variation in starting time due to the individual blocks. In order to balance any difference which might be present, the back block on top of the track is interchanged with the block in the back hole in the track so that half of the readings in each part of the experiment are made with one block and half with the other.

As far as the sprinter is concerned, the physical conditions under which he starts do not differ materially from those used in competition. In this experiment, each sprinter ran alone, thus eliminating the element of competition.

In all experiments a maximum of twelve starts in one day was ob-

served. In each experiment the starts from the blocks were alternated with the starts from the holes in order to balance any outside influence which might be present, yet unobserved, in the experiment.

THE DATA

Data were collected from a group of twenty-eight men including ten champions, eleven high-class sprinters, five who had had experience, and two exceptional athletes without track experience. The championship group contained high school and college champions in the sprint events. The high-class sprinters, designated as such by Mr. Bresnahan and Mr. Hayden, are members of the varsity track teams of the State University of Iowa and Coe College. The experienced group consists of those who have had experience in running and were average college sprinters. The two men without track experience were exceptional athletes in other sports.

Forty-two starts were made by each subject from the blocks on top of the track and a like number by each subject from holes in the track. Since twelve starts were made the limit for any one day (that is six from the blocks and six from the holes) each subject came to the laboratory seven times. When the subject arrived he changed to track equipment and proceeded to "warm up" as was his custom before a race. As soon as the sprinter felt that he was ready the readings were taken.

SUMMARY AND DISCUSSION

In order that the main points brought out in this investigation may be more succinctly discussed, the data are summarized in Table I.[6]

There are a number of points of interest brought out by these data. The most outstanding thing about the data is that in the case of every subject their mean starting time from starting blocks is distinctly shorter than from the holes in the track, regardless of the method of starting previously used or the amount of experience credited to the subject. In twenty-three of the cases the observed difference is more than four times its probable error, which indicates that these subjects did not start faster from the blocks on the basis of chance; in fact, it is practically certain that the difference is a true one. In five cases the critical ratio is less than 4.00, the smallest being 1.97. In this case there are about ninety-one chances in a hundred that the difference in mean starting time is significant.

But we must not let these data lead us to believe that even though the mean difference between starting time from blocks and out of holes is highly significant in favor of the starting blocks, that these men start faster from blocks every time. In the column "Distribution of Starts," in Table 1, data are given which show the number of times that the starts are faster from blocks. Of the twenty-three cases where the difference in

[6]The raw data are on file in the Library of the State University of Iowa.

mean starting time is four or more times the probable error, two subjects started faster from the blocks 93 per cent of the time, one 90 per cent, one 88 per cent, three 83 per cent, three 81 per cent, three 79 per cent, one 78 per cent, two 76 per cent, one 75 per cent, three 74 per cent, and three 71 per cent. Out of the group where the difference between the mean starting time from holes and blocks was less than four times the probable error, the distributions show that one of the five started faster from the blocks 61 per cent of the time, one 62 per cent, one 66 per cent, one 73 per cent, and one 74 per cent.

Another point not to be overlooked is the experience which the various subjects had with the blocks, the holes, or both. In the case of five subjects whose difference in starting time from the holes and the blocks was less than four times their probable errors, none of them had ever started from blocks before. On the other hand eight of the remaining twenty-three subjects where the mean difference between starting time from holes and from blocks was four or more times the probable error, had never used starting blocks before the time of this experiment. The per cent of the time which this group starts faster from blocks than from holes range from seventy-one to ninety.

The following is a per cent distribution of the starts of the whole group:

93% of the starts of two subjects were faster from blocks
90% of the starts of one subject were faster from blocks
88% of the starts of one subject were faster from blocks
83% of the starts of three subjects were faster from blocks
81% of the starts of three subjects were faster from blocks
79% of the starts of three subjects were faster from blocks
78% of the starts of one subject were faster from blocks
76% of the starts of two subjects were faster from blocks
75% of the starts of one subject were faster from blocks
64% of the starts of four subjects were faster from blocks
73% of the starts of one subject were faster from blocks
71% of the starts of three subjects were faster from blocks
66% of the starts of one subject were faster from blocks
62% of the starts of one subject were faster from blocks
61% of the starts of one subject were faster from blocks

On this basis, the data seemed to show conclusively that starting blocks give a sprinter an advantage, but the important question to be answered is—what is the significance of this advantage? On the basis of observed difference in starting time, the group of 12 subjects who had had experience with both holes and blocks in starting had a mean starting advantage of .0378 seconds by using blocks. For the group of 13 who had never used blocks before, the mean advantage was .0309 seconds in starting from blocks. The subject who had never used holes before had an advantage of only .0150 seconds by using blocks. The two subjects, who had had no experience in starting, had an advantage of .0536 seconds and .0367 seconds respectively by the use of blocks. Although the blocks

gave every subject an advantage in the start the mean advantage is .0337 ± .0021 seconds, with a range of .0075 ± .0038 seconds to .0676 ± .0059 seconds. Now, on the assumption that a high-class 100-yard dash man runs the distance in 10 seconds, then .1 second is equivalent to 3 feet provided the increment of distance is uniformly covered. On this basis then, in case of the group studied, the blocks give a mean advantage of 1 foot with a range of 2.7 inches to 2 feet. On the basis of the data presented in this paper, even though an advantage in starting is only .0075 seconds, it is very important and must be taken into account since many races are decided on differences as small as 2.7 inches.

The data presented in this experiment indicate quite conclusively that starting blocks give a sprinter an advantage in starting a race. It might appear on first thought that this statement is made on the basis of too few data. However, in considering the question the writers felt justified in terminating the experiment with data from twenty-eight subjects since the results were consistent, there being not a single exception.

CONCLUSION

The data presented in this investigation justify the conclusion that the elapsed time between the stimulus (gun shot) and the breaking of the contact of the "back foot" is shorter where starting blocks are used than where holes in the track are employed.

TABLE I

A Comparison of the Starting Time of Sprinters from Starting Blocks and Holes in the Track

Subject No.	Mean Starting Time Holes	Mean Starting Time Blocks	Observed Difference	Critical Ratio A	Chance of a true diff.	Distribution of starts *H.*	Distribution of starts *B.*
	sec.	sec.	sec.				
1	.1425± .0057	.0994± .0031	.0432± .0064	6.73	100	9	33
2	.1374± .0033	.0851± .0034	.0521± .0048	10.54	100	3	39
3	.1939± .0025—	.1812± .0030	.0127± .0039	3.26	99	16	26
4	.0722± .0024	.0581± .0024	.0141± .0034	4.15	100	10	30[1]
5	.1466± .0028	.0925± .0022	.0541± .0040	13.53	100	4	38
6	.1293± .0036	.0918± .0031	.0475± .0048	9.88	100	8	34
7	.1665± .0056	.1304± .0029	.0361± .0063	5.73	100	10	32
8	.1251± .0042	.0885± .0041	.0366± .0058	6.31	100	11	31
9	.1563± .0027	.1198± .0021	.0365± .0034	10.74	100	8	34

TABLE I (Continued)

A COMPARISON OF THE STARTING TIME OF SPRINTERS FROM STARTING BLOCKS AND HOLES IN THE TRACK

Subject No.	Mean Starting Time Holes	Mean Starting Time Blocks	Observed Difference	Critical Ratio A	Chance of a true diff.	Distribution of starts *H.*	Distribution of starts *B.*
10	.1582± .0032	.1286± .0034	.0296± .0047	6.30	100	11	31
11	.1211± .0026	.1102± .0033	.0109± .0042	2.60	96	16	25[2]
12	.1377± .0021	.1227± .0010	.0150± .0028	5.36	100	9	33
13	.1398± .0031	.1227± .0032	.0171± .0044	3.89	99.5	11	31
14	.2597± .0029	.2522± .0023	.0075± .0038	1.97	91	14	27[3]
15	.2357± .0058	.2146± .0059	.0211± .0082	2.57	95	15	27
16	.1488± .0050	.1330± .0058	.0158± .0077	2.05	91	11	29[4]
17	.1775± .0030	.1539± .0043	.0236± .0052	4.63	100	9	32[5]
18	.2295± .0037	.1759± .0058	.0536± .0064	8.38	100	8	34
19	.2116± .0046	.1518± .0049	.0598± .0067	8.93	100	7	35
20	.1862± .0052	.1186± .0028	.0676± .0059	11.46	100	3	39
21	.1897± .0044	.1420± .0028	.0477± .0049	9.73	100	7	35
22	.1652± .0029	.1366± .0045	.0286± .0054	5.30	100	7	35
23	.1902± .0045	.1365± .0034	.0537± .0056	9.61	100	5	37
24	.1870± .0034	.1397± .0036	.0473± .0049	9.65	100	9	33
25	.1503± .0045	.1222± .0026	.0281± .0052	5.40	100	10	32
26	.1857± .0050	.1531± .0031	.0326± .0059	5.53	100	12	30
27	.2043± .0037	.1658± .0058	.0385± .0068	5.66	100	12	30
28	.1560± .0028	.1340± .0027	.0160± .0039	4.10	100	12	30
Mean			.0337± .0021				

[1] 2 starts even
[2] 1 start even
[3] 1 start even
[4] 2 starts even
[5] 1 start even

III. THE OPTIMUM TIME FOR HOLDING A SPRINTER BETWEEN THE "SET" AND THE STIMULUS (GUN SHOT)

By

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THE interval of time that a sprinter should be held on his marks after he is "set" has long been a controversial question among track coaches and officials. This detail in the start is of paramount importance, because if a sprinter is to get away to a good start he must be ready both physically and mentally when the gun is fired. At the command "on your marks," the sprinter begins his first preparations for leaving his marks. During this time he is paying attention to the adjustment of his feet on the blocks, sizing up his opponents and making various other preliminary adjustments. However, when the command "get set" is given the sprinter quickly raises into position and immediately begins concentrating on the "gun."

Experimental evidence shows that it takes a little time for the attention to reach its maximum peak, and, if the best possible start is to be executed, the apex of attention and the "gun" must coincide. Attention has been proven to be a fluxuating phenomenon. It reaches a peak, and then subsides, coming back to its peak again. Now, if the gun is fired before or after the peak of attention is reached, the start will be obviously slower than if the peak of attention and the stimulus coincide.

In order to throw some light on this question, the investigation herein reported was carried out.

THE OBJECT OF THE EXPERIMENT

The purpose of this investigation is to determine the optimum time for holding a sprinter between the "set" and the stimulus (gun shot).

DEFINITION OF "SET"

In this experiment the term "set" is defined as that period of momentary steadiness, which a sprinter reaches after the command "get set." In other words, it is that position of steadiness which a sprinter assumes immediately before leaving his marks.

REVIEW OF LITERATURE

A search of the literature reveals only one report which has any direct bearing on the question with which we are dealing in this experiment.

Nakamura[7] was the first to investigate the optimum time for holding a sprinter between the command "get set" and the gun. This investigator equipped the trigger of his starting gun with electric contacts, so that at the firing of the gun a chronoscope was started. The hands of his subjects were placed on contacts so that when they were lifted the chronoscope was stopped. By this method Nakamura recorded starting time. In order to determine the optimum time between the command "get set" and the "gun," starting times were compared for intervals of 1 second, 1.5 seconds, and 2 seconds. This investigator reports 1.5 seconds as the best of the three intervals which he investigated. When 1.5 seconds elapsed between the command "get set" and the "gun," the starting time of his subjects was materially shorter than when the interval was either 1 second or 2 seconds. Although, in Nakamura's experiment, an interval of 1.5 seconds between the command "get set" and the "gun" gave shorter starting time than either 1 second or 2 seconds, it only proves that 1.5 is the best of the three intervals investigated but shows nothing concerning the optimum time.

It must be remembered that the time interval investigated in the experiment reported here is different than that studied by Nakamura. He studied the interval between the trigger contact on the gun and the lifting of the hands from the track, while we investigated the interval between the "gun shot" and the beginning of the start as indicated by the breaking of a contact between the back foot and the block.

TECHNIQUE

In order to determine the best time to hold a sprinter between the "set" and the "gun," starting times for 1 second, 1.2 seconds, 1.4 seconds, 1.6 seconds, 1.8 seconds, and 2 seconds were studied. In order to determine the time intervals a technique was devised for measuring starting time and holding time.

Starting Time.—In order to measure starting time, an apparatus was arranged which provided for starting a chronoscope with a gun shot and for stopping it by a contact which was made when the back foot of a sprinter left a starting block. The chronoscope reading between these two events was considered as starting time. The details of the apparatus and technique have been described in Part I of this study.

The Interval Between the "Set" and the "Gun."—A stop watch was employed for determining the proper interval between the "set" and the "gun." Before beginning the experiment the starter practiced until he was able to accurately time each interval. Although we have overlooked the influence of the individual reaction time of the experimenter in starting and stopping the watch, we feel that the preliminary practice reduced

[7] H. Nakamura, "Experimental Study in Reaction Time of Start for Running Race," *Jap. J. Psychol.*, 1928, III, 231–262.

this element to a minimum. By taking a large number of readings it is felt that the starter's reaction time is submerged. In considering the question of measuring the interval between the "set" and the "gun," the stop-watch method was adopted because there seemed to be no way available which completely ruled out the reaction time of the experimenter.

The procedure was to give the command "on your marks," "get set," and the "gun." As soon as the sprinter came to a momentary steadiness in the "get-set" position, the watch was started, and at the end of the proper interval, the gun was fired.

In general, the procedure consisted in having each subject come to the laboratory and change to track equipment, after which he proceeded to "warm up" in the usual manner. As soon as the subject felt that he was ready the measurements of starting time were made.

Since 6 different intervals between the "set" and the "gun" were

TABLE II

THE OPTIMUM TIME FOR HOLDING A SPRINTER BETWEEN THE "SET" AND THE STIMULUS (GUN SHOT)

Sub. No.	Time interval between "set" and the stimulus (gun shot) 1.0 sec.	1.2 sec.	1.4 sec.	1.6 sec.	1.8 sec.	2.0 sec.
1	.1567	.1563	.1347	.1284	.1418	.1428
2	.1250	.1213	.1197	.1175	.1217	.1355
3	.2085	.2128	.1953	.1893	.2085	.2319
4	.1204	.1096	.1037	.0493	.1096	.1054
5	.1948	.1772	.1453	.1862	.1533	.1562
6	.1200	.1229	.1126	.1164	.1288	.1293
7	.1410	.1147	.1115	.1148	.1252	.1176
8	.1407	.1380	.1343	.1351	.1416	.1456
9	.1256	.1254	.1168	.1102	.1280	.1328
10	.1093	.1030	.0968	.0933	.1113	.1133
11	.1214	.1267	.1160	.0982	.1171	.1352
12	.1565	.1718	.1361	.1605	.1553	.1516
13	.2000	.1938	.1802	.1681	.1849	.1834
14	.1594	.1556	.1439	.1416	.1483	.1598
15	.1448	.1385	.1098	.1140	.1245	.1424
16	.0873	.0976	.0882	.0848	.0868	.0877
17	.1374	.1311	.1259	.1306	.1337	.1521
18	.1611	.1503	.1391	.1424	.1574	.1626
19	.1144	.1136	.1099	.1087	.1085	.1264
20	.1573	.1642	.1453	.1397	.1642	.1585
21	.1410	.1560	.1336	.1402	.1397	.1068
22	.2369	.2329	.2197	.2272	.2413	.2404
23	.1286	.1217	.1253	.1204	.1297	.1315
24	.1358	.1283	.1236	.1155	.1295	.1433
25	.1275	.1326	.1059	.1012	.1086	.1256
26	.1905	.1674	.1588	.1860	.1787	.1896
27	.1394	.1400	.1047	.1027	.1203	.1215
Mean	.1476	.1447	.1311	.1302	.1400	.1478
P.E.	±.00409	±.00419	±.00394	±.00418	±.00415	±.00421

studied, 168 starts were required of each subject, that is, 28 starts for each interval. It should be stated that in the case of 4 subjects the number of starts fell short of 28 for each interval due to conditions which arose that were not under our control, thus reducing the actual number of starts studied to 4,368. In order to eliminate the element of fatigue 4 starts for each interval, making a total of 24, were taken at each experimental period. This required that each subject come to the laboratory at least 7 times. It was felt that 28 starts for each interval were a sufficient number for a reaction of this nature to make the data significant.

THE DATA

Data were collected from 27 male subjects varying in track ability from those who had practically no experience to those who were champions. A summary of the data collected from the entire group is shown in Table II. By comparing the means it is obvious that for the whole group the optimum holding time between the "set" and the "gun" is 1.6 seconds. Table III shows a mathematical comparison of each holding time with every other.

TABLE III

THIS TABLE SHOWS THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE VARIOUS HOLDING TIMES

		Obtained Difference	$\frac{D}{\text{P.E. Diff.}}$	Significance (Chances)
1.0 sec. vs.	1.2 secs.	.0030 ± .0031	.97	74
	1.4 secs.	.0165 ± .0057	2.90	97
	1.6 secs.	.0174 ± .0058	3.00	98
	1.8 secs.	.0076 ± .0058	1.31	81
	2.0 secs.	.0002 ± .0059	.03	51
1.2 secs. vs.	1.4 secs.	.0136 ± .0058	2.34	94
	1.6 secs.	.0145 ± .0059	2.46	95
	1.8 secs.	.0047 ± .0059	.79	71
	2.0 secs.	.0031 ± .0060	.52	63
1.4 secs. vs.	1.6 secs.	.0009 ± .0058	.16	54
	1.8 secs.	.0089 ± .0057	1.56	85
	2.0 secs.	.0167 ± .0058	2.88	97
1.6 secs. vs.	1.8 secs.	.0098 ± .0059	1.66	87
	2.0 secs.	.0176 ± .0060	2.93	97
1.8 secs. vs.	2.0 secs.	.0078 ± .0059	1.32	81

The above comparison in Table III shows that 1.4 seconds and 1.6 seconds are practically equal in desirability as holding times between the "set" and the "gun." There are 97 chances in 100 that 1.4 seconds is a better holding time than 1.0 second; 94 chances that it is better than 1.2; 54 chances that 1.6 seconds is better than 1.4 seconds; 85 chances that 1.4 seconds is better than 1.8 seconds; and 97 chances that it is better than 2.0 seconds. There are 98 chances in 100 that 1.6 seconds is

better than 1.0 second; 95 chances that this interval is better than 1.2 seconds; 54 chances that it is better than 1.4 seconds; 87 chances that it is better than 1.8 seconds; and 97 chances that this holding time is better than 2.0 seconds.

It is very obvious from the data that 1.0 second is too short and that 2.0 seconds is too long for holding a sprinter between the "set" and the "gun." Furthermore, it is evident that there is no choice between 1.0 second and 2.0 seconds. Furthermore, it is seen that 1.2 seconds and 1.8 seconds are about equally desirable, being better than 1.0 second and 2.0 seconds, but much less desirable than either 1.4 seconds or 1.6 seconds.

The data clearly show that the extremes on the short interval end, viz., 1.0 second and 1.2 seconds are too short and that the extremes on the long interval end, viz., 1.8 seconds and 2.0 seconds are too long, while 1.4 seconds and 1.6 seconds are optimum.

TABLE IV

THE DISTRIBUTION OF THE STARTS AMONG THE TIME INTERVALS INVESTIGATED FOR HOLDING A SPRINTER BETWEEN THE "SET" AND THE STIMULUS (GUN SHOT)

Sub.	Time interval between "set" and the stimulus (gun shot)					
	1.0 sec.	1.2 sec.	1.4 sec.	1.6 sec.	1.8 sec.	2.0 sec.
1	1	2	8	10	2	5
2	5	3	6	7	4	3
3	4	3	6	8	4	3
4	0	2	8	10	3	5
5	1	1	9	13	2	2
6	3	4	8	6	2	5
7	2	5	4	10	2	5
8	1	7	5	9	4	2
9	6	3	7	5	4	3
10	3	3	6	13	0	3
11	3	2	4	15	3	1
12	5	0	10	4	3	6
13	0	2	7	11	5	3
14	2	4	8	7	5	2
15	2	2	9	9	5	1
16	6	4	5	6	4	3
17	2	3	11	8	4	0
18	3	2	10	8	3	2
19	3	6	7	7	5	0
20	3	1	10	10	2	2
21	4	1	10	5	5	3
22	4	4	11	2	4	3
23	1	5	7	9	2	4
24	3	2	7	7	4	1
25	2	3	8	8	3	0
26	1	4	8	1	3	3
27	0	2	6	7	1	0
	—	—	—	—	—	—
	70	80	205	215	88	70

Further evidence that 1.4 seconds and 1.6 seconds are the optimum times for holding a sprinter between the "set" and the "gun" is given in Table IV. In this table a distribution of the starts is given. Under each interval the number of times that the starting time was faster for the holding time as indicated is given for all subjects. Out of a total of 728 rounds of 6 starts each made by the 27 subjects, 70 of them were shorter when the holding time was 1.0 second; 80 of them were shorter when the holding time was 1.2 seconds; 205 were shorter when the holding time was 1.4 seconds; 215 were shorter when the holding time was 1.6 seconds; 88 when it was 1.8 seconds; and 70 when it was 2.0 seconds. Out of the 728 rounds, 420 of them are shortest when the holding time between the "set" and the "gun" is 1.4 seconds and 1.6 seconds, while the remaining 308 rounds are about equally distributed among the other 4 holding times investigated. These data reinforce those given in Table II on the basis of mean starting time, which show the optimum times to be 1.4 seconds and 1.6 seconds with no appreciable choice between them when it comes to advantageous starting.

DISCUSSION

Although the data show quite conclusively that the holding times of 1.4 - 1.6 seconds are the most desirable times for holding a sprinter between the "set" and the "gun," we do not wish to leave the impression that a sprinter always starts faster when one of these intervals is used. The data show that a very large majority of sprinters are more likely to be ready when these times are observed. It is seen from Table II that 1.6 seconds was the optimum holding time for 62.9 per cent of the subjects while 1.4 seconds was optimum for 33.3 per cent, and 1.8 seconds for 3.8 per cent (one subject).

Although the tendency of the data is to show that the shortest holding time (1.0 second) and the longest (2.0 seconds) is the least desirable in the majority of the cases (15), this is not always true. For the times below the optimum, 67 per cent of the subjects started slowest when the holding time was 1.0 second and 33 per cent when the holding time was 1.2 seconds. For the times above the optimum, 81 per cent started slowest when the holding time was 2.0 and 19 per cent when it was 1.8 seconds.

It is evident from the data herein presented that if a sprinter is held approximately 1.5 seconds between his "set" and the "gun," the chances are significantly greater that he will get his optimum start.

We have not overlooked the fact that the problem of the optimum holding time for a group of runners participating in the same race presents a more complicated situation than that reported here. However, we hope that these data will serve as a valuable guide to officials in estimating the time which they allow between the "set" and the "gun."

CONCLUSION

The data presented in this study justify the following conclusions:

1. For 62.9 per cent of 27 subjects the optimum holding time between the "set" and the stimulus (gun shot) is 1.6 seconds and for 33.3 per cent of them it is 1.4 seconds, and for one man it was 1.8 seconds (3.8 per cent). A hold of 1.5 seconds would seem to fall within the optimum range for all subjects.

2. For 67 per cent of the 27 subjects studied their poorest starting time below the optimum was at 1.0 second and for 33 per cent of them it was poorest at 1.2 seconds. For 81 per cent of the cases the poorest starting time above the optimum was at 2.0 seconds and 19 per cent at 1.8 seconds.

Procedures in Educational Research

II. THE ELEMENTS OF STATISTICS[1]

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STATISTICS is the science that deals with the collection, tabulation, analysis, and interpretation of data. The tendency to examine the results of measurement rather than to depend wholly on practical judgments in determining the effects of experimental and other procedures, makes it necessary for competent students in various social fields to master at least the elements of statistical method. The student must be able, first, to understand and evaluate quantitative reports made by other students in his field, and second, to prosecute the quantitative aspects of his own investigations in terms of appropriate methods and recognized terminology. In other words, he must be familiar with statistical method.

Statistical method has often been erroneously classified as a "method of research," along with the descriptive method, the philosophic method, the causal method, and so on. Statistical method is, rather, a mode of operation with data, whatever the method of research may be, and is an adjunct to any research procedure that yields data.

Notes on the history of statistics.—The rapid development of a science of statistics during the past half century has been based largely on the theoretical foundations laid by mathematicians of the preceding two centuries, especially Bernoulli, DeMoivre, Laplace, Gauss, and Quetelet. A surprising fertility in applying mathematical theory to social measurements was shown by the versatile Sir Francis Galton (1822–1911), who may be called the father of statistics. Most of his contributions to statistics were made during the last quarter of the nineteenth century. To him we owe much of the present terminology, including correlation, decile and percentile, median, quartile, and regression. Since about 1890 Professor Karl Pearson has exerted a tremendous influence on the development of statistical theory. He has not only extended and refined the measures proposed by Galton but has also made prolific original contributions. Among the better-known terms and methods originated by Pearson are biserial *r*, the chi-square test of goodness of fit, the

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coefficient of contingency, the coefficient of variation, correlation ratio, mode, partial correlation, the product-moment method of correlation, and standard deviation.

Twentieth century progress in statistics has been remarkable for the profusion of statistical refinements suggested, for the extensive use of statistical methods in social and biological studies, for the wide dissemination of statistical knowledge and skill through college courses, and for the rapid growth in the number of trained statisticians at work in various fields. While the first course in statistics in an American university was offered at Columbia University in 1880 in the department of economics, and only about a dozen such courses were offered altogether, in all departments of American colleges and universities, in 1900; Glover's figures[1] indicated that in 1925 more than four hundred statistics courses were offered by 84 higher institutions in mathematics, economics and social studies, schools of business, education, psychology, public health, and agriculture. The present total of statistics courses in all colleges and universities in the United States probably amounts to several thousand.

The nature of this course in statistics.—This introduction to statistics is concerned with only the most elementary concepts and skills in statistical analysis. Since it is intended for students with relatively little training in mathematics, it demands mathematical proficiency only to the extent of a knowledge of arithmetic and the ability to substitute in a formula. The preliminary matter, below, deals briefly with characteristics of measurement, kinds of scores, procedures in tabulation, and graphical presentation. The statistical measures then explained and illustrated may be described informally as follows: (1) measures of typical or average performance—central tendency, (2) measures of general range or scatter—dispersion, (3) measures of an individual's place in the group—relative position, (4) measures of agreement of results in measuring two traits of the same people—relationship, correlation, and (5) measures of chance fluctuation of statistical results—unreliability. These statistical measures are computed from the individual measurements (test scores, heights, ages, or the like) that constitute the data.

MEASUREMENT AND TABULATION

Approximation in measurement.—Every measurement is an approximation. The reported measurement indicates the value (e.g., length, weight, time) *to the nearest unit* of some kind, or as ages are commonly stated, to the last unit completed. If the length of a table to the nearest inch is 42 inches, its true length may be any value between 41.5 inches and 42.5 inches. If a person's age to last birthday is 21 years, his actual

[1]As quoted by Helen M. Walker in *Studies in the History of Statistical Method*, p. 170. Baltimore: The Williams and Wilkins Company, 1929.

age may be any value between 21 years and 22 years. The range of possible values in either case equals one unit, of the unit of measurement.

Significant figures.—In a numerical result the digits (figures) known to be correct are called significant figures. If the dimensions of a rectangle are 17.3 inches and 19.8 inches, each measurement being correct to the nearest tenth of an inch, each dimension is said to be correct to three significant figures. If the area of this rectangle is considered 17.3×19.8 the result is 342.54. But the *minimum* actual area would be $17.25 \times 19.75 = 340.6875$ while the *maximum* actual area would be $17.35 \times 19.85 = 344.3975$. Only the first two figures for this area (the 300 and the 40), appear in each result. Only these two figures, therefore, can be stated with certainty. Since 340 is less than any possible value, it is well to give a next figure that is likely to be least in error. This figure is obtained by *rounding* the first result, 342.54, to 343. The last digit is somewhat doubtful, and any additional figures would obviously have little chance of being correct. As a general rule, *the number of significant figures in a product is not more than the least number of significant figures in any one of the factors.* Similarly, the number of significant figures in a quotient cannot exceed the least number of significant figures in the divisor or the dividend.

A pure number (e.g., the 5 in 5×376 feet) is exact and may therefore be considered as having an unlimited number of significant figures. The number .00023 has two significant figures, the zeros serving only to make it hundred-thousandths. With the decimal point, 400. has three significant figures; without it, 400 has one significant figure.

A common error in student reports is that of carrying statistical results beyond the limit of any possible significance. Such results are both spurious and misleading. Possible accuracy depends fundamentally on the precision of the original data, not on the number of decimal places to which the statistical results are carried. There is no statistical procedure that can extort reliable conclusions from bad data.

Random sampling.—Frequently it is desirable to select a large representative sample to typify data from a source that yields more items than it is possible to study. Such a selection of data should constitute a *random sample,* drawn by chance so that another sample taken in the same way would probably be of almost precisely the same character. The guiding principle in choosing the sample is, that all items the source yields must have practically equal *chances* of being included in the sample. Examples of method are (1) choosing names from an alphabetical list at stated intervals—every tenth name, or sixth from the top of every twentieth page, or the like, and (2) drawing items at random from a container in which they have been thoroughly mixed. Other methods will occur to the student. To give the laws of chance a fair trial the sample ought to include some forty or fifty items, at least. The

method of selection may be governed to some extent by the magnitude of the sample desired.

Arrangement of raw data.—The data (scores, measures, or other figures in the form in which they are obtained are called the raw data. If the number of items is small, it may be desirable to base comparisons and analyses on these data, merely rearranging them in order of size. For large samples, however, it is expedient to present them in a frequency table, grouping the items (measures). In the following pages various statistical procedures are illustrated with both grouped and ungrouped measures.

Construction of a frequency table.—The first task in constructing a frequency table is to select the *class interval,* the numerical span that defines the groups of measures to be classified together. In the adjoining table the interval is 10, and the following scores have been recorded in the second column by means of tally marks: 86, 42, 63, 54, 80, 27, 47, 96, 68, 74, 60, 62, 24, 77, 53, 67, 40, 59, 65, 78, 46, 83, 75, 53, 66, 52, 87, 69, 58, 71. The tally column should be omitted in the finished table. The number of items, N, is the sum of the numbers in the frequency column. Notice that the intervals are arranged in order, with the highest values at the top, and that no intervals are omitted even if the corresponding frequencies are zero.

Interval	Tally	Frequency
90–99	/	1
80–89	////	4
70–79	~~////~~	5
60–69	~~////~~///	8
50–59	~~////~~/	6
40–49	////	4
30–39		0
20–29	//	2
		$N=30$

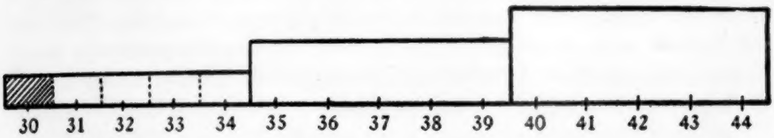
All intervals in a given table should be equal. The width of the interval used in a table may be readily discovered by subtracting the lowest score to be recorded in one interval from the lowest score to be recorded in the interval next above it. Observe that the lowest score to be recorded in any interval is a multiple of the width of the interval. Here, 20, 30, 40, and so on, are multiples of the width 10.

As a rule, the number of intervals in a table should not be less than some ten or twelve; otherwise the shape of the distribution tends to be obliterated in a few large steps (intervals). On the other hand, the number of intervals should not exceed twenty or twenty-five, for then it is difficult to comprehend the table quickly, computation is more difficult, and no useful purpose is served.

The width of the interval to be used, therefore, is selected in terms of having an appropriate number of intervals and of using a numerically convenient width. The most convenient widths are 1, 2, 5, 10, 20 or 25, 50, and so on. In making the choice, first determine the lowest item and the highest item. If these are 73 and 98, a convenient interval is 2, since

that will make fourteen intervals. If the range is 37 to 84, a convenient interval is 5; of course the scores to be recorded in the lowest interval in this case would be 35–39. The lowest score to be recorded in any interval is a multiple of the width of the interval—for the sake of convenience.

The limits of an interval.—Statistically the measures in each interval are treated as if they were spread evenly through the interval. The resulting errors mostly compensate for each other, but a measure of the final unreliability should always be provided (see later). The accompanying figure illustrates three intervals having different frequencies and representing measurements to the nearest unit. The heights are proportional to the frequencies (e.g., 2, 4, 6). For each possible recorded value the segment taken on the base line represents the range of the possible true values. Thus, 30 extends from 29.5 to 30.5. The intervals, therefore,



adjoin each other, and there is no gap between 34 and 35, or between 39 and 40, for instance. The limits of the first interval are readily seen to be 29.5 and 34.5; of the next, 34.5 and 39.5; and so on. These values are known as the *class limits*; that is, the limits of the class interval.

With measurements to the nearest unit, each class limit should fall mid-way between two consecutive units. Thus, if measurements are made to the nearest fourth of an inch, and the class interval is 2 inches, the limit of the interval containing the measures 46–$47\frac{3}{4}$ should be $45\frac{7}{8}$ and $47\frac{7}{8}$.

With measures to the last unit completed (e.g., age to last birthday) the class limits obviously fall at the lowest measures to be recorded in the intervals. If the unit is a year, for instance, and the interval is 5, the limits of the interval in which ages 15–19 are recorded are 15 and 19.999 +.

Class value.—Since the scores in each interval are treated as if they were spread evenly through it, the average value of the scores in any interval is taken to be the value of the midpoint of the interval. This value, the class value, is easily determined by adding half the width of the interval to the lower *limit* of the interval. Thus the class values of the intervals shown in the preceding figure are 32, 37, and 42; and the class value of the age-interval given at the end of the preceding paragraph is 17.5.

Discrete scores.—Scores that are the result of counting a series of things (number of pupils in a school, number of examples right on an arithmetic test, or the like) are said to be *discrete*—that is, separate.

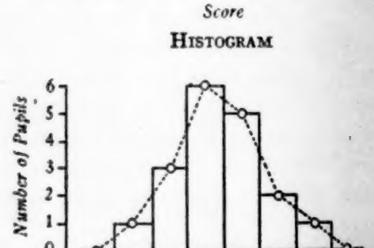
Each item is a thing that is counted *all or none*. Hence there are no possible values between 17 and 18, or 18 and 19. In other words, 18 means *exactly* 18. When such scores are arranged to form a frequency distribution they, too, are treated as if in each interval they were spread evenly through the interval. In the frequency table, then, discrete scores are "expanded" to form a continuous distribution, and the 18 that means 18 is treated as if it meant 17.5–18.5. That is, in the frequency distribution we treat discrete items precisely as if they were measurements to the nearest unit.

Three kinds of scores.—The discussion above has pointed out (1) measurements to the nearest unit, (2) measurement to the last unit completed, and (3) discrete scores. Of these, (1) and (3) are treated alike, statistically. The remaining type (2) is not often encountered. Most class intervals, therefore, should be considered as having limits one-half unit below the lowest score recorded in the interval and one-half unit above the highest score recorded in the interval. It is mathematically better to write the *limits* to describe each interval; but usually we write only the lowest and the highest scores because it is briefer and is not confusing if the theoretical basis of intervals is understood.

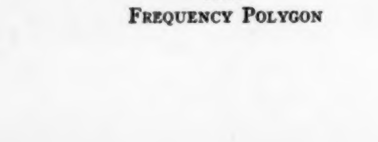
Graphs of the frequency distribution.—The two common devices for graphical presentation of a frequency distribution are known as the *histogram*, and the *frequency polygon*. In constructing either, divisions of the base line are marked off in multiples of the width of the class interval. The vertical scale is expressed in terms of frequency. The accompanying diagrams illustrate the devices as applied to a very short series.

FREQUENCY TABLE

Interval	Frequency
65–69	1
60–64	2
55–59	5
50–54	6
45–49	3
40–44	1



HISTOGRAM



FREQUENCY POLYGON

Observe that the vertical lines in the histogram are erected at the *limits* of the class intervals. Each rectangle, then, is an accurate graphical representation of an interval as that interval is treated statistically; that is, as if the scores were spread evenly throughout the interval.

The frequency polygon is formed by joining a series of points with *straight* lines, each point being plotted above the *class value* of an interval at a height representing the frequency for that interval. The points at the ends of the distribution appear on the base line at the midpoints of the adjacent intervals having zero frequency.

The histogram is generally to be preferred, because it is more completely in accord with assumptions used in statistical computation, and is at least as true a picture of the data.

A frequency polygon should never be rounded freehand to appear as a smooth curve. Curve fitting is a complex branch of statistics, not a casual operation to be done by guess.

MEASURES OF CENTRAL TENDENCY

Kinds of averages.—Any measure of central tendency is known in statistics as an average. The common elementary-school practice of using the term *average* to designate a specific kind of average, therefore, should be avoided in the interest of clarity. The principal measures of "what the average person does" are the mean, the median, and the mode. The mean is the "arithmetic average"—the result of dividing the sum of the measures by the number of measures. The median is the midmost measure, the one above and below which equal numbers of measures occur. The mode, which means the "fashion," is the measure (score) that occurs most frequently (or is made by the largest number of people).

Two averages whose computation is not described in this article, but which are useful in treating certain types of data, are the geometric mean and the harmonic mean. The geometric mean should be used with data that increase in a relatively constant ratio, as for example with population statistics. The harmonic mean is used chiefly in transformations; for example, of mean time to mean rate, or vice versa. The term *mean*, alone, should always be understood to indicate the arithmetic mean.

Any average, of course, represents a *point* on the scale of measurement; a point whose location answers the question, from one interpretation or another, "what does the average person do?" or what does he have, or what is the average number or weight of groups of things, or the like.

The mean.—The mean is the most universally satisfactory average. It has good stability; that is, it fluctuates little under sampling. It has superior algebraic properties, making it adaptable to the needs of satisfactory computation and manipulation; it is easily understood; and it is

involved in refined measures of dispersion, correlation, and so on. In its simplest expression the formula for computing the mean is

$$M = \frac{\Sigma X}{N}$$

where M is the mean, ΣX is the sum of all the measures,[1] and N is the number of measures. Applying this formula to the data in the adjoining X column, $M = 968 \div 13 = 74.46$.

X	X'
89	14
83	8
80	5
78	3
77	2
75	0
74	−1
73	−2
73	−2
71	−4
69	−6
65	−10
61	−14
$\Sigma X = 968$	$\Sigma X' = -7$

$N = 13$

This procedure, however, is slow and cumbersome. Even for a dozen or so cases it is inferior. Let us try a better method. These numbers, 89, 83, and so on, are expressed in terms of their deviations from *zero*. It can easily be shown that if they are expressed in terms of their deviations from *any* other number, an *arbitrary origin*, which we shall designate by A, the formula for the mean becomes

$$M = A + \frac{\Sigma X'}{N}$$

where $X' = X - A$. If for this same column, then, we take A as 75, the X' values are 14, 8, 5, and so on, $\Sigma X'$ is −7, and

$$M = 75 + \frac{-7}{13} = 75 - .54 = 74.46.$$

Each of the items in the X' column is obtained by subtracting 75 from the corresponding item in the X column.

The advantages of this short-cut may readily be seen in an illustration of the procedure for computing the mean of a large number of items in a frequency distribution. The expression $\Sigma X'$ now becomes $\Sigma fd \times h$, and

$$M = A + \frac{\Sigma fd}{N} \times h$$

$$\text{Then } M = 57 + \frac{-62}{285} \times 5 = 57 - 1.09 = 55.91.$$

It is most convenient of course, to take A as the midpoint (class value, see p. 135) of an interval near the middle of the distribution. Here, A is the class value of the 55–59 interval. Since the deviations are counted in class intervals, we must multiply by h, the width of the

[1] The sign of summation is Σ, the Greek capital "sigma." It is not an algebraic quantity, and means "the sum of" the measures indicated. Thus, Σf means the sum of the frequencies; and therefore $\Sigma f = N$.

interval, to express the amount in units. Of course the multiplication and division are done before the addition or subtraction.

I	f	d	fd	$\Sigma' fd$	Check		
					d'	fd'	$\Sigma' fd'$
90–94	1	7	7		8	8	
85–89	3	6	18		7	21	
80–84	7	5	35		6	42	
75–79	11	4	44		5	55	
70–74	19	3	57		4	76	
65–69	26	2	52		3	78	
60–64	38	1	38	251	2	76	
55–59	56	0			1	56	412
50–54	43	−1	−43		0		
45–49	31	−2	−62		−1	−31	
40–44	20	−3	−60		−2	−40	
35–39	14	−4	−56		−3	−42	
30–34	9	−5	−45		−4	−36	
25–29	4	−6	−24		−5	−20	
20–24	1	−7	− 7		−6	− 6	
15–19	2	−8	−16	−313	−7	−14	−189

$N = 285$ $\Sigma fd = -62$ $\Sigma fd' = 223$

Computation of the mean is readily checked by moving the arbitrary origin. If A is moved a distance of one class interval, up or down, $\Sigma fd'$ should be $\Sigma fd \mp N$. Here, A was moved down and $\Sigma fd' = -62 + 285 = 223$. The remaining computation may well be done to complete the check:

$$M = 52 + \frac{223}{285} \times 5 = 52 + 3.91 = 55.91.$$

The median.—Fundamentally, the median is a counting average; that is, it is located by counting half the cases from either end of the distribution when the items are arranged in order of size. By definition the median is the midmost measure. That means that the median of 21 cases would be the eleventh, when they are arranged in order of size, because the eleventh would then be the middle (midmost) measure—with 10 scores on either side of it. It must be clear that when the number of measures is odd, one of the actual measures is midmost. But if the number of cases is even, for example 18, the median lies at a point between the two middle scores; usually it is located halfway between them. With 18 cases, then, the median would be halfway between the ninth and the tenth case. The medians of the columns at the top of the next page are 34 and 85.

In the frequency distribution (illustrated on the lower part of this page) the median is determined by ***interpolation***. Counting proceeds to the interval in which the median occurs, and the proper part to be added, from that interval, is calculated by a simple proportion. Let us consider an example. The median is at the point on either side of which half of 157 cases (in the *f* column) occur; that is, 78.5 cases. Beginning at the bottom, we find that there are 59 cases below the 80–89 interval; and adding the 26 cases in that interval would make more than 78.5. Therefore, the median is in that interval. But 78.5 is only 19.5 more than 59. Hence we need only 19.5 of the 26 cases; that is, 19.5 twenty-sixths the interval. Since the width of the interval is 10 units, the part to be added (from the median interval) is $\frac{19.5}{26} \times 10$ when we express it in units. If we add that to the value we had reached with the 59 cases, we shall have the median. The 59 cases took us to the lower limit of the 80–89 interval, which is 79.5 (see p. 135). Therefore the computation is,

	99
46	95
42	93
40	92
39	91
38	90
38	88
37	87
35	86
34	84
33	83
32	81
31	80
30	77
28	73
27	70
25	70
21	65
$N = 17$	$N = 18$

$$Md = 79.5 + \frac{19.5}{26} \times 10 = 79.5 + 7.5 = 87.0$$

The computation may be checked by calculating the median anew, beginning at the upper end of the distribution. In that case, obviously, it will be necessary to *subtract* the proportional part (of the interval in which the median occurs) from the *upper* limit of the interval. The check follows.

$$Md = 89.5 - \frac{6.5}{26} \times 10 = 89.5 - 2.5 = 87.0$$

I	*f*	
150–159	2	
140–149	0	
130–139	1	
120–129	5	72
110–119	13	
100–109	22	
90– 99	29	
80– 89	26	
70– 79	21	
60– 69	17	
50– 59	12	59
40– 49	7	
30– 39	2	

$N = 157$

For those who like to have formulas for each measure to be computed, we add the formulas for the median; although it is probably more difficult in this case to use the formulas than to proceed on the basis of the understanding supplied in the explanation given above.

Common errors in computing the median are to use the class value of the interval instead of its class limits, and to use the lowest and highest scores in the interval as the class limits.

In these formulas *l.l.* is the lower limit of the median interval, f_m is the frequency for that interval, f_b the frequency below it, *u.l.* is the upper limit of the median interval, f_a the frequency above it, and h the width of the intervals.

$$Md = l.l. + \frac{\frac{N}{2} - f_b}{f_m} \times h$$

$$\text{(Check)} \quad Md = u.l. - \frac{\frac{N}{2} - f_a}{f_m} \times h$$

The mode.—The mode is not used enough in research to warrant much consideration here—and anyway, it has no special virtues. In ungrouped data it is determined by inspection, being merely the score made by the largest number of people. For the frequency distribution a value for the mode may be obtained by use of the formula

$$Mo = M - 3(M - Md).$$

When a distribution shows two distinct "humps," instead of the more usual bell-shape, it is said to be bimodal.

Uses of the mean and the median.—The median is ordinarily the convenient measure of central tendency for use with small groups and for crude statistical work. Certainly, for the purposes of most classroom teachers it is fully satisfactory. Of course the value of median is not affected by high scores in a top-heavy distribution, or by the low ones in a bottom-heavy array. The mean, on the other hand, is affected by the *values* of *all* the scores.

The mean is the preferred average for research work generally. It is capable of rigorous algebraic definition, its superior algebraic properties make it nicely adaptable to the exigencies of computation, and it is the average that is demanded for use with certain other important statistical measures. The mean is recommended, therefore, for use in most research and for statistical data of various kinds.

MEASURES OF DISPERSION

Deviation, variability, or dispersion.—The scatter of the measures in a group, or frequency distribution, is commonly described in statistics by any one of three practically interchangeable terms: deviation, variability, and dispersion. While an average represents a *point* on the scale, a measure of dispersion represents a *distance* on the scale—usually measured from some average. The simplest measure of dispersion is the *range,* which is merely a statement of the span from the lowest to the highest score; for example, 28–97, if the lowest score is 28 and the highest 97,

with the others somewhere between. But the range is quite an unsatisfactory measure, because the position of a single end-score may extend or limit the range very significantly. For statistical use, therefore, other measures of variability have been devised to overcome this objection. The more important of these measures are the quartile deviation, the mean deviation, and the standard deviation. Each indicates the range of a central portion of the distribution, instead of the range of the entire series of scores.

The quartile deviation.—A measure of the middle half of the scores is the "semi-interquartile range" or, more simply, the quartile deviation. The quartile points, indicated by Q_1 and Q_3 are the points below which one-fourth and three-fourths of the cases occur; Q_0 and Q_4 would be the ends of the distribution, of course, and Q_2 would be the median. The quartile deviation, then, is half the range from Q_1 to Q_3. To express it as a formula,

$$Q = \frac{Q_3 - Q_1}{2}$$

where Q is the quartile deviation. The method of finding Q_1 and Q_3 is precisely the same as for finding the median, except that one-fourth and three-fourths of the cases are counted, instead of half. In the accompanying example, one-fourth of the cases is 34.5, and Q_1 is 34.5 cases above the lower end of the distribution. Since there are 23 cases below the interval 20–21, and 15 cases in it, Q_1 lies in that interval. Similarly, since three-fourths of N is 103.5, Q_3 lies in the interval 28–29. The complete calculation follows.

I	*f*		
38–39	1		
36–37	3		
34–35	0		
32–33	8		
30–31	11		
28–29	16		
26–27	23		
24–25	20		
22–23	18		
20–21	15		
18–19	10		99
16–17	7	23	
14–15	4		
12–13	2		

$N = 138$

$$\tfrac{3}{4}N = 103.5;\ 103.5 - 99 = 4.5$$

$$Q_3 = 27.5 + \frac{4.5}{16} \times 2 = 27.5 + .56 = 28.06$$

$$\tfrac{1}{4}N = 34.5;\ 34.5 - 23 = 11.5$$

$$Q_1 = 19.5 + \frac{11.5}{15} \times 2 = 19.5 + 1.53 = 21.03$$

$$2\overline{)7.03}$$

$$3.51$$

$$Q = \frac{28.06 - 21.03}{2} = 3.51$$

The results may be checked by calculating the quartile points from the upper end of the distribution. It may help in studying the quartile deviation to review the explanations of computation of the median.

In terms of *numbers of cases* the median is exactly halfway between Q_1 and Q_3 and therefore it often is not exactly halfway between them in terms of *distances on the scale*. Hence, $Md + Q$ may not equal Q_3 and $Md - Q$ will not always equal Q_1; but the differences, in general, will be small. It should be remembered, then, that $Md \pm Q$ defines the range approximately of the middle 50 percent of the scores. Thus, if Md is 89 and Q is 16, roughly half of the scores in this distribution are between 73 and 105.

The mean deviation.—If the separate deviations (of the scores) from some average are added, and this quantity is divided by the number of scores, the result is the mean deviation. Theoretically the best average for this purpose is the median, but it makes little difference and the mean is used almost exclusively because of its superior algebraic properties. The mean deviation, hence, is commonly *the mean of the deviations from the mean.* It is readily demonstrable that the sum of the positive deviations from the mean equals the sum of the negative deviations from the mean. The algebraic sum of all the deviations is zero. In computing the mean deviation, the deviations are added regardless of sign, that is, we find the sum of their *absolute values*. Expressed as a formula the definition is

X	$\|x\|$
38	5.8
36	3.8
35	2.8
34	1.8
33	.8
33	.8
32	.2
30	2.2
27	5.2
24	8.2
10)322	31.6
$M = 32.2$	

$$M.D. = \frac{31.6}{10} = 3.16$$

$$M.D. = \frac{\Sigma|x|}{N}$$

where $|x|$ is the absolute value of a score's deviation from the mean; in other words, where $|x| = X - M$ regardless of whether the difference is positive or negative.

Even in the short series shown here, the work is complicated by the fractions in the $|x|$ values. A formula which avoids this difficulty in dealing with the frequency distribution is to be found in statistics textbooks, but is not given in this paper because the mean deviation is used hardly enough to justify it. The preceding explanation is given so that the reader will be able to interpret the measure where it does occur in the literature.

The expression $M \pm M.D.$ defines the range of the middle 55 or 60 percent of the cases in a fairly symmetrical distribution.

The standard deviation.—Statistically the most important measure of dispersion is the standard deviation, which may be defined as the root-mean-square of the deviations from the mean. It may be computed without algebraic refinements by squaring the separate deviations from the

mean, adding these squares, dividing this sum by the number of observations (cases, scores) and then finding the square root of this result. The definition expressed as a formula is

$$S.D. \text{ or } \sigma = \sqrt{\frac{\Sigma x^2}{N}}$$

where σ (which is small *sigma*) is the symbol for the standard deviation. This procedure is illustrated in the accompanying example; but even with this simplified series the amount of arithmetical computation is excessive. A derived formula for the frequency distribution will eliminate unnecessary "figuring." The formula is

$$\sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2} \times h.$$

X	x	x^2
88	4.8	23.04
85	1.8	3.24
84	.8	.64
84	.8	.64
83	— .2	.04
83	— .2	.04
83	— .2	.04
82	—1.2	1.44
81	—2.2	4.84
79	—4.2	17.64

10)832 51.60
$M = 83.2$

$$\sigma = \sqrt{\frac{51.60}{10}} = 2.3$$

I	f	d	fd	$\Sigma' fd$	fd^2
160–164	1	7	7		49
155–159	0	6			
150–154	2	5	10		50
145–149	3	4	12		48
140–144	5	3	15		45
135–139	8	2	16		32
130–134	11	1	11	71	11
125–129	16	0			
120–124	13	—1	—13		13
115–119	9	—2	—18		36
110–114	6	—3	—18		54
105–109	3	—4	—12		48
100–104	0	—5			
95– 99	2	—6	—12		72
90– 94	1	—7	— 7	—80	49
	$N = 80$			$\Sigma fd = -9$	$507 = \Sigma fd^2$

In the example the items for the fd^2 column are conveniently obtained by multiplying the preceding two columns; that is, d by fd. Here

$$\sigma = \sqrt{\frac{507}{80} - \left(\frac{-9}{80}\right)^2} \times 5 = \sqrt{6.34 - .01} \times 5 = 2.52 \times 5 = 12.6$$

The standard deviation is the appropriate measure of dispersion for use with the mean, and the range defined by $M \pm \sigma$ includes the middle

two-thirds of the cases, generally. One-sixth of the cases, then, exceed the mean by more than one *sigma*, and a sixth are less than the mean by more than a sigma.

Uses of measures of dispersion.—By nature the quartile deviation is adapted to use with the median, and the standard deviation with the mean. The quartile deviation and the median are easily computed but loosely defined, and are quite satisfactory for work with small samples (such as a schoolroom class) where more rigorous measures would imply greater reliability than could be obtained. The mean and the standard deviation are the instruments for research and for statistical data in large, reliable samples.

MEASURES OF RELATIVE POSITION

Kinds of measures of position.—A statistical measure of position may be based on place in terms of the individuals in the group or in terms of scale. Ranks of one kind or another are in terms of people; and standard scores, sigma values, T-scores, and so on, are in terms of the scale.

Ranks.—Ordinarily the *rank* of a score means its place, counting from the top, when the scores are arranged in order of size. Thus, if a score has a rank of 12 it means that only 11 were better—but there may have been only 12 in the group. The same rank may be very poor for a small group but very good for a large one. This difficulty of interpretation is mostly overcome by the use of *percentile ranks* which are expressed in terms of the percentage of scores a given score *equals or exceeds.*

Units

Tens	0	1	2	3	4	5	6	7	8	9	
13	/ (3)				/ (2)		/ (1)				3
12		// (11.5)			/// (9)	/ (7)		// (5.5)		/ (4)	9
11		//// (20.5)		// (17.5)	/ (16)		// (14.5)		/ (13)		10
10			/ (25)		/ (24)			/ (23)			3
9	// (27.5)					/ (26)					3
8				/ (29)							1
	3	6	1	3	6	2	3	3	1	1	29

The *classifier* shown here is very convenient for ranking scores. In this classifier the tens digits are at the left of the rows and the rows are for the scores from 80 to 89, 90 to 99, and so on, the units digits being above the columns. The range of these scores is from 83 to 136. Each tally mark represents a score. The totals appear at the bottom and on the right, thus providing a check. The encircled figures are the ranks.

Since $N = 29$, the last rank should be 29. But if we assign rank 5 to both scores in the box for 127, and do similarly for other tied scores, the last rank will be only 19; which would be misleading, to say the least. The difficulty in such cases is surmounted by giving tied scores the ***mean*** of the ranks they would have if they were not tied. The next assignable rank (in the next box) being the next rank *after* the ranks the tied scores would have had (if they had not been tied). Thus the tied scores of 127 *would* have had ranks 5 and 6. They get 5.5, and the next assignable rank is 7.

These ranks may be converted into percentile ranks by means of the formula

$$P.R. = \frac{100\ (N + 1 - R)}{N}, \text{ or } P.R. = 100 - \frac{100\ (R - 1)}{N}$$

where R is the rank assigned in the classifier. The score 107 has a rank of 23, which is equivalent to a percentile rank of

$$\frac{100\ (29 + 1 - 23)}{29} = \frac{700}{29} = 24.$$

The two ranks mean (1) that 107 is 23rd among 29 scores, or that 22 of the 29 are better, and (2) that 107 equals or exceeds 24 percent of the scores in this distribution.

In the frequency distribution the procedure for finding the point (on the scale) below which any given percentage of the scores occur is found by the same method as the median and the quartile points. Using P with a subscript to indicate the percentiles, we may note that $Md = P_{50}$; $Q_1 = P_{25}$; and $Q_3 = P_{75}$. To compute P_{63} for example, count up through 63 percent of the cases, instead of 25 percent as for Q.

Comparable scores.—Substantially the various devices for expressing different scores on different scales in comparable terms, are devices for showing the relative position of the scores in their several distributions. Now, then—a pupil may take a standardized test on reading and one on arithmetic. The tests may not have equal numbers of items. For instance, one test may have 200 items and the other 75. If the pupil makes 160 on the reading test and 50 on arithmetic, that's no evidence as to how well he did on either, or as to which he is relatively better in. The mean will give us some clue, but it doesn't tell us anything about the spread. The standard deviation does. And if we express Johnny's scores in terms of *S.D.*'s from the mean, it will indicate his relative success in his various groups in comparable terms. Such a *standard score* is obtained by dividing x, the deviation of the score from the mean, by σ, the standard deviation of the group. A series of scores for a pupil may be compared, by means of standard scores, in the manner illustrated here.

The standard scores, $x \div \sigma$, simply show how many sigmas the original scores are above or below the means for their distributions. Since five-sixths of the scores (in a fairly symmetrical distribution) are below $M \div \sigma$, the pupil whose scores are given here is in the highest sixth of the classes in spelling and history. The score in arithmetic is about a fourth of a sigma below the mean, and in reading about half a sigma above.

Subject	Test Score	M	x	σ	$x \div \sigma$
Spelling	38	35	3	2.5	+1.20
Arithmetic	126	130	−4	15.3	−0.26
History	73	66	7	4.2	+1.67
Reading	59	53	6	11.1	+0.54

In an approximately normal distribution a range of $M \pm 3\sigma$ includes more than 99 percent of the cases.

Uses of measures of relative position.—Ranks are satisfactory measures of position in most classroom situations, where the number of scores is clearly recognized. Percentile ranks are better for most purposes, with groups of twenty or more pupils, because they eliminate the necessity for continually referring to the number of scores involved; but they require more calculation. For comparisons and analyses in research, standard scores are the appropriate measures.

MEASURES OF RELATIONSHIP—CORRELATION[1]

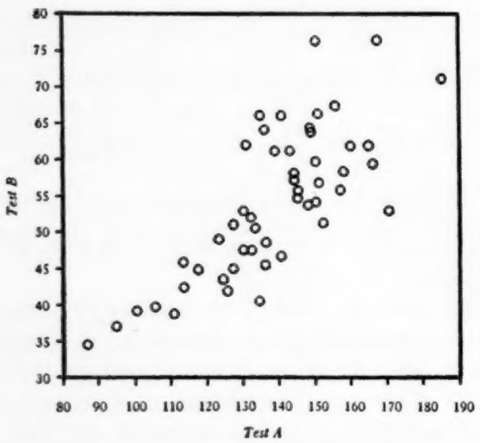
The nature of correlation.—Two or more series of things are often associated; that is, they vary together—they are correlated. Children's success in school may tend to vary with the incomes of their parents. Pupils who succeed in mathematics may also tend to succeed in Latin. Such association of facts is measured by the *coefficient of correlation,* which indicates the *degree of association.* If the pupil who got the highest score in arithmetic also got the highest score in spelling, and the relative positions of other pupils in the two subjects likewise showed perfect correspondence, the scores would illustrate *perfect positive correlation.* If the pupil who got the highest score in arithmetic got the lowest score in spelling, while the next pupil was second from the top in arithmetic and second from the bottom in spelling, and so on, these scores would illustrate *perfect negative correlation.*

It may be shown that the coefficient that expresses perfect positive correlation is 1.00 and the coefficient that expresses perfect negative

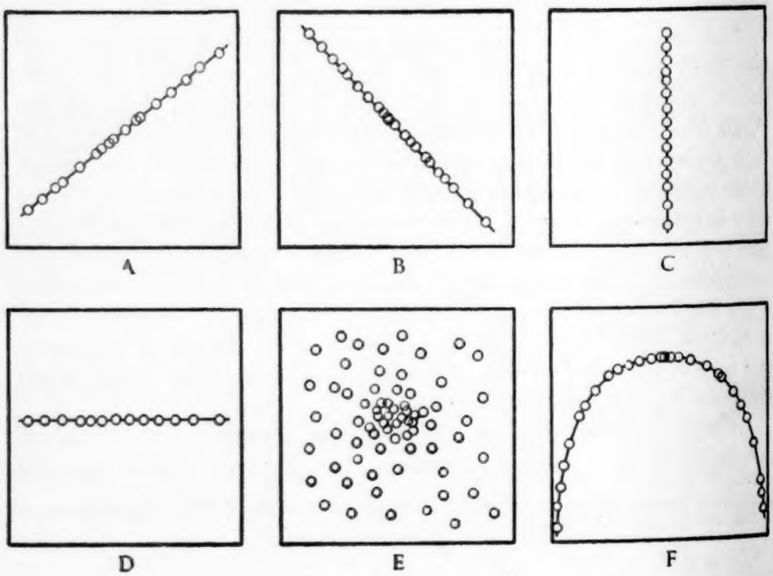
[1] Only *linear* correlation is explained in this discussion. Non-linear correlation is beyond the scope of this treatment.

correlation is —1.00. Other degrees of association are expressed by coefficients between these two values. The coefficient that lies mid-way between the two extremes is zero (.00), and it indicates no dependence of association.

The scatter diagram.—In the accompanying figure each dot represents two scores of a single pupil. The figure is called a scatter diagram.



The score on Test A may be read on the horizontal scale, and the score on Test B on the vertical scale. Notice that, in general, pupils who did well on one test also did well on the other, and vice versa. The computed coefficient of correlation between the two sets of scores was found to be .72. If this positive correlation had been perfect (+1.00) the points representing the scores would have been on a straight, diagonal line as illustrated in the accompanying figure, A. The second figure (B) in this



series shows the line that denotes perfect negative correlation (-1.00). Parts C and D indicate zero correlation—there can be no dependence of association if all the scores in one variable are tied—and Part E indicates very low, if any, correlation (there is no discernible trend). Part F illustrates "non-linear" correlation, of which special measures are available in more advanced courses.

The numerical bases of correlation.—Two methods of computing the coefficient of correlation are in common use: the Pearson product-moment method, and the Spearman rank-difference method. The product-moment method takes into account the actual values of all the scores, which in the process are converted into standard scores, although the conversion is not apparent to the beginner. The rank-difference method is based on the ranks of the scores in the group, making no allowance for the fact that scores with consecutive ranks tend to be close together in the middle of the distribution and far apart at the ends. Theoretically the two methods give almost identical results. Actually, as we shall see, the results may be quite different.

The rank-difference method.—The coefficient of correlation cannot be computed easily by the rank-difference method for more than thirty or forty pairs of scores. For small groups, however, it is a convenient method of obtaining a measure of correlation. The coefficient is indicated by ρ (the Greek letter "rho") and the formula is

$$\rho = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

where D is the difference of the ranks of a pair of scores and N is the number of pairs. The formula may be derived from Pearson's formula, given later. A short series of scores is given here to illustrate the computation of ρ. Notice that the pairs of scores (one pair for each pupil)

Pupil	Test X	Test Y	R_x	R_y	D	D^2
A	83	160	3	1	2	4.
B	46	38	10	10		
C	92	143	1	2.5	1.5	2.25
D	81	67	4	9	5	25.
E	70	124	8.5	5	3.5	12.25
F	70	117	8.5	7	1.5	2.25
G	75	132	6	4	2.	4.
H	88	143	2	2.5	.5	.25
I	74	121	7	6	1.	1.
J	79	113	5	8	3.	9.

$N = 10$ $\Sigma D^2 = 58.00$

$$\rho = 1 - \frac{6 \times 55}{10 \times 99} = 1 - .35 = .65$$

must not be separated or arranged in rank order, for the difference of each pupil's two ranks is to be obtained. The rank on Test X is indicated in the R_x column and the rank on Test Y in the R_y column. Since the difference D is to be squared, it is of no consequence whether it is positive or negative.

Ties in score often result in ranks and differences ending in .5. Such numbers are readily squared by following a simple procedure. Let us illustrate. Assume that the number to be squared is 6.5. The decimal part of the result is always .25 and the whole-number part is the units digit (or digits—in this case, 6) multiplied by one more than that digit. In this case $6 + 1 = 7$, so that $(6.5)^2 = 6 \times 7 + .25 = 42.25$; and $(8.5)^2 = 8 \times 9 + .25 = 56.25$; also $(11.5)^2 = 11 \times 12 + .25 = 132.25$; and so on.

The product-moment method.—The fundamental method of correlation is the Pearson product-moment method. The coefficient is indicated by r, and the basic formula is

$$r = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

where each xy is the product of two deviations: the deviation of an X score from the mean of the X's, and the deviation of the corresponding Y score from the mean of the Y's; and where N is the number of pairs, σ_x the standard deviation of the X's, and σ_y the standard deviation of the Y's. This formula, or its equivalent—

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \cdot \Sigma y^2}}$$

may be used in computing coefficients of correlation for small groups. But the method is much more tedious than that for computing ρ, and since the significance of correlation in small groups is slight, anyway, the advantages of the better method (product-moment) in such cases do not justify the extra labor involved.

With data for thirty or more pairs, the product-moment method is both quicker and better. The formulas above, however, need to be modified to simplify computation. The recommended formula looks frightfully complicated, but it makes computation quite easy. It is

$$r = \frac{\Sigma f_{xy}d_xd_y - \dfrac{(\Sigma f_xd_x)\ (\Sigma f_yd_y)}{N}}{\sqrt{\left[\Sigma f_xd_x^2 - \dfrac{(\Sigma f_xd_x)^2}{N}\right]\left[\Sigma f_yd_y^2 - \dfrac{(\Sigma f_yd_y)^2}{N}\right]}} = \frac{a}{\sqrt{bc}}$$

in which the small x's and y's merely tell whether the f's and d's are for the X scores or the Y scores. The only quantity, then, that presents any

difficulty is the $\Sigma f_{xy}d_xd_y$. The computation is best carried forward with a "two-way correlation table."[1]

The accompanying table (below) illustrates the procedure. The scores of a group of pupils on two tests, X and Y, have been tabulated as in a scatter diagram. On Test X the range of scores was 82–137, and a class interval of 5 was used in the tabulation. On Test Y the range was 32–55, and a class interval of 2 was used. The 1 in a cell in the top row

Test X

Test Y	80	85	90	95	100	105	110	115	120	125	130	135		f_y	d_y	f_yd_y	$f_yd_y^2$
54										1 (5)				1	5	5	25
52											1 (4)	1 (4)		2	4	8	32
50									2 (6)	1 (3)				3	3	9	27
48							1 (2)	2 (4)		2 (4)	1 (2)			6	2	12	24
46					1 (1)	1 (1)	4 (4)	2 (2)	1 (1)					9	1	9	9
44				2 (0)		1 (0)	2 (0)	1 (0)	3 (0)	1 (0)				10	0		
42		1 (-1)		1 (-1)	2 (-2)	5 (-5)	3 (-3)	2 (-2)	1 (-1)					15	-1	-15	15
40			2 (-4)		1 (-2)	3 (-6)		1 (-2)						7	-2	-14	28
38			1 (-3)	4 (-12)	2 (-6)	1 (-3)								8	-3	-24	72
36			2 (-8)		1 (-4)									3	-4	-12	48
34	1 (-5)	2 (-10)		1 (-5)										4	-5	-20	100
32	1 (-6)		1 (-6)											2	-6	-12	72
f_x	2	3	6	8	7	11	10	8	7	5	2	1	70	N		-54	452
d_x	-5	-4	-3	-2	-1	0	1	2	3	4	5	6				Σf_yd_y	$\Sigma f_yd_y^2$
f_xd_x	-10	-12	-18	-16	-7		10	16	21	20	10	6	20	Σf_xd_x			
$f_xd_x^2$	50	48	54	32	7		10	32	63	80	50	36	462	$\Sigma f_xd_x^2$			
$\Sigma' f_{xy}d_y$	-11	-11	-21	-18	-13	-13	3	2	6	12	6	4	-54	Σf_yd_y			
$d_x\Sigma' f_{xy}d_y$	55	44	63	36	13		3	4	18	48	30	24	338	$\Sigma f_{xy}d_xd_y$			

was recorded for the scores of a pupil who made 127 on Test X and 55 on Test Y. The large figure in each cell represents the number of pupils whose pairs of scores fell within the limits of that cell. (Pay no attention to the small figures for the present.) The last four columns on the right are the f's, d's, fd's, and fd^2's for the Y scores, each item in the f_y column being the sum of the large figures in the cells of its row. The other three columns simply repeat the procedure already learned in connection with the standard deviation: d_y is the deviation (in class intervals) from the arbitrary origin, f_yd_y is the product of f_y and d_y, and $f_yd_y^2$ is the product of d_y and f_yd_y.

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[1] Printed forms for computation by the technique described here are available from Professor Karl J. Holzinger, University of Chicago. The symbols and procedures used here are based on the methods used with his correlation forms.

The first four rows below the plotted scores carry out the same procedure for the X scores, the arrangement being vertical instead of horizontal.

The purpose of the small figures in the cells is to assist in getting the next-to-bottom row. Each of these figures is the product of the frequency for its cell and the y deviation for its row. They can be supplied more easily, therefore, by writing all of them for one row before going to the next. The sum of all the small figures in each column is then recorded in the next-to-bottom row. The total of the figures in this row should be the same as that of the next-to-last column, for each total is $\Sigma f_{xy} d_y$. This fact provides a convenient check; if the two results do not agree, the preceding work must be gone over to find the error.

The figures in the bottom row are obtained by multiplying each item in the next-to-bottom row by the x deviation in the same column (recorded three rows above).

Now for substitution in the formula: $r = \dfrac{a}{\sqrt{bc}}$ where

$$a = \Sigma f_{xy} d_x d_y - \frac{(\Sigma f_x d_x)\ (\Sigma f_y d_y)}{N}$$

$$b = \Sigma f_x d_x{}^2 - \frac{(\Sigma f_x d_x)^2}{N}$$

$$c = \Sigma f_y d_y{}^2 - \frac{(\Sigma f_y d_y)^2}{N}$$

In the example we have been studying the figures are as follows (rounding the figures to the nearest unit in each fraction):

$$a = 338 - \frac{(20)\ (-54)}{70} = 338 + 15 = 353$$

$$b = 456 - \frac{(20)^2}{70} = 456 - 6 = 450$$

$$c = 452 - \frac{(-54)^2}{70} = 452 - 42 = 410$$

$$\text{Then } r = \frac{353}{\sqrt{450 \times 410}} = .82$$

Choice of method.—For rough work with small samples, the rank-difference method of correlation is to be preferred because of its simplicity. The instrument for correlation in research, and for use with large samples in any case, is the product-moment method. Theoretically, as determined on the basis of the normal probability curve and from

the fact that the rank-difference method is derived from the product-moment method, the two methods are almost equivalent; the formula for correcting ρ gives a maximum correction of .018. Practically, however, the difference is likely to be much larger. When there are ties in rank, the value for ρ is spuriously increased. At the worst, if all the scores on one test are the same and if no two scores are the same on the other test, the procedure for computing ρ yields an apparent correlation of .50. Obviously the true correlation is zero—the value that is obtained by the product-moment method.

Correlation and causation.—A quarter of a century ago much emphasis was placed on the value of correlation for determining whether one factor was the *cause* of another. The fallacy of such inference is now rather widely recognized. There is no evidence, in a mere coefficient of correlation, as to whether (1) either factor is caused by the other, (2) both are the result of a common cause, or (3) the two factors happen to be associated by chance. The coefficient is only an index to the degree of association, whatever may be the cause. Determination of the cause is a problem for application of logic, in investigation by methods other than correlation.

Predictive value of the coefficient of correlation.—Assuming that the data used in correlation are reliable measures of a properly chosen random sample, the coefficient indicates the *probable* degree of association to be found in like measures of a similarly chosen sample from the same total group of data. The coefficient, under such circumstances, has high predictive value (within limits of error discussed below) for groups that constitute good random samples. For individual scores, however, the predictive value is much lower; that is, what is true "on the average" is much less likely to be true for individuals chosen at random.

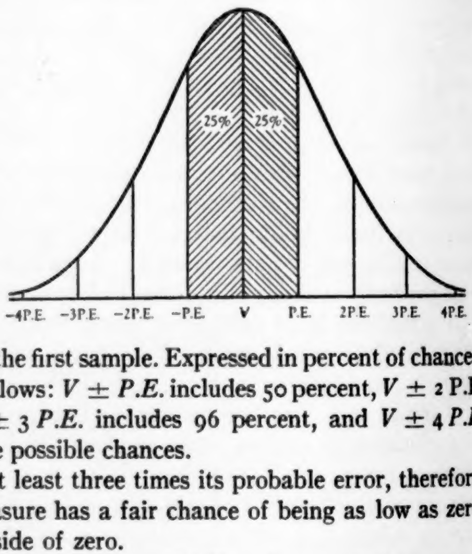
"High" and "low" correlations.—It is generally misleading to refer to coefficients in a given range as being "high" and to those in another range as being "low," regardless of the type of data involved. *High* and *low* are relative terms. For example, 10 feet would be high for a step but low for a house. A coefficient of .80 is not always high, and one of .25 is not always low (although it may have little significance). The size of a coefficient should be judged in terms of similar results for the same pair of variables; that is, other correlations between measures of the same traits. These similar results are to be sought in the reports of investigations, past and present and future.

MEASURES OF UNRELIABILITY—PROBABLE ERROR

Computed values and possible values.—Each statistical measure is based on results obtained with a particular sample. With another sample the results would probably not be the same. The computed value is

simply a *probable* value. Reliability of a measure is its tendency to remain constant for various samples. It is indicated by attaching to the computed value an indication of the range of a portion of the possible true values. It may be shown that these possible true values are distributed about the computed value in accordance with the "law of chance" forming a normal probability distribution as illustrated here. In the figure, V is the computed value. The formulas for the *probable error* are so constructed as to indicate the range of the middle 50 percent of the possible true values by the expression $V \pm P.E.$

Illustration of the probable error.—If a measure is reported as $12.3 \pm .6$, it means that the probable error of the measure is .6, and that the chances are 50 out of a hundred that the computed value of that measure in a similar sample would be between 11.7 and 12.9. The chances are also 50 out of a hundred that the new computed value would differ from 12.3 by more than .6; that is, 25 out of a hundred that it would be below 11.7, and 25 out of a hundred that it would be above 12.9. The figure illustrates the increasing certainty that a new computed value will be within 2 *P.E.*, 3 *P.E.*, and 4 *P.E.* of the value computed from the first sample. Expressed in percent of chances, the probabilities are as follows: $V \pm P.E.$ includes 50 percent, $V \pm 2$ P.E. includes 82 percent, $V \pm 3\,P.E.$ includes 96 percent, and $V \pm 4\,P.E.$ includes 99 percent of the possible chances.



Unless a measure is at least three times its probable error, therefore, the true value of the measure has a fair chance of being as low as zero, or even on the opposite side of zero.

Formulas for probable error.—The reliability of a sample is increased if, other things remaining unchanged, the size of the sample is increased. Also, samples are more reliable if the dispersion is slight. Two items, then, affect the measure of unreliability (probable error): greater dispersion makes it larger, more cases make it smaller. Various formulas for probable error follow:

PROBABLE ERROR FORMULAS

1. Mean: $$P.E._M = .675\ \frac{\sigma_x}{\sqrt{N}}$$

2. Difference of two means, A and B: $P.E._{A-B} = \sqrt{(P.E._A)^2 + (P.E._B)^2}$

3. Standard deviation: $$P.E._{\sigma} = .675 \frac{\sigma}{\sqrt{2N}}$$

4. Pearson coefficient of correlation: $$P.E._{r} = .675 \frac{1 - r^2}{\sqrt{N}}$$

If Group A has a mean of 80 ± 3 a spelling test and Group B has a mean of 72 ± 4 on the same test, it is not at all certain that Group A is the better, for the difference is 8 ± 5. The difference is not very significant, because the *P.E.* is nearly as large as the measure.

If a coefficient of correlation is .63 ± .08 the true correlation may be as low as .40 or as high as .90.

In fact there is a remote chance that a computed value may be in error (though all computation be perfect) by 5, 6, 7, or even more, times the *P.E.* The ends of the probability curve *approach* the base line, but they never reach it, just as zero is never reached if only half of whatever you may have is subtracted, then half of the remainder, and so on.

Since the probable error is a measure based on the theory of chance, it should never be used with very small samples, for such samples are excessively unreliable. A good arbitrary minimum is thirty or forty cases.

STATISTICAL METHOD IN RESEARCH

Use in reading the literature.—A first step in investigating any problem is to find out what others have already done toward solving it. What others have done, aside from expressing opinions and making speculations, is mostly to be found in reports of research involving data treated by statistical methods. An important function of an elementary knowledge of statistics, therefore, is that of assisting in the interpretation of such reports. While many of the reports involve terminology and procedure beyond the scope of this introduction to statistics, the matters presented here are those of widest and most basic application.

Use in performing research.—Statistical method is no substitute for thinking. It is rather a means of analyzing data into facts expressed in standard quantitative terminology as an aid to thinking. The main processes of research depend largely on inductive logic. But statistical method does make it possible to determine whether, on the basis of the measurements at hand, one group is better in a trait than another, whether a group has made gains during an interval between tests, and the like.

The reader who has completed this introductory course needs to consider himself one who has looked upon a portion of the promised land, not one who has traveled widely in it or lived long within its boundaries.

A comprehension of statistical method depends, for one thing, on a considerable knowledge of the mathematical theory on which it is based. The techniques presented here can be used with reasonable safety under competent advice. For those who wish to become capable of self-direction and to have a considerable degree of confidence in approaching the statistical part of an investigation, the next step is to study the subject in appropriate textbooks, preferably with the assistance that can be obtained in college courses in statistics. A list of several good textbooks follows. These books are suitable for reference, for self-instruction, or for college and university classes.

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HOLZINGER, KARL J. *Statistical Methods for Students in Education.* Boston: Ginn and Company, 1928. Pp. viii + 372.

Very sound and thorough. Requires fair knowledge of college algebra. An authoritative work.

KELLEY, TRUMAN L. *Statistical Method.* New York: The Macmillan Company, 1923. Pp. xii + 390.

An advanced book, for students with training in higher mathematics.

MILLS, FREDERICK CECIL. *Statistical Methods Applied to Economics and Business.* New York: Henry Holt and Company, 1924. Pp. xvi + 604.

Summaries and chapter on index numbers especially valuable. Requires knowledge of algebra.

MUDGETT, BRUCE D. *Statistical Tables and Graphs.* Boston: Houghton Mifflin Company, 1930. Pp. viii + 194.

A convenient reference, especially pp. 29–88.

RUGG, HAROLD O. *Statistical Methods Applied to Education.* Boston: Houghton Mifflin Company, 1917. Pp. xviii + 410.

Very useful for supplementary reading. A pioneer book in its field.

THURSTONE, L. L. *The Fundamentals of Statistics.* New York: The Macmillan Company, 1925. Pp. xviii + 238.

One of the more elementary books. A sound book, as well as simple and clear.

YULE, G. UDNY. *An Introduction to the Theory of Statistics.* London: Charles Griffin and Company, 1924 (revised). Pp. xv + 415.

A classic textbook that has gone through many editions. Difficult for the novice. Requires thorough knowledge of algebra. Still one of the best general treatises.

Pupil Objectives in High School Physical Education

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PHYSICAL education, like all other subjects, has been dominated by the adult educators and their ideas.* Unlike many other subjects in the curriculum, it is possible in classes of physical education to use material which is, to a large extent, determined by the pupil's likes, dislikes, and expectancies. This study is an attempt to find, in a limited manner, the type of achievements which pupils expect from their classes in this department.

In order to secure this information, the questionnaire was adopted as the best method for this particular problem. This questionnaire was the product of the ideas of six experienced physical education teachers, both men and women, taking graduate work at the State University of Iowa, and of a group of high school boys and girls from the Iowa City public schools and from the University Experimental School.

This questionnaire was given in four school systems in which physical education classes had been taught by regular teachers for at least five years. A Wisconsin town of 2,200 population and three Iowa cities of 15,000, 27,000, and 150,000 population, respectively, were used in this study. In all, 1,400 students answered these questionnaires in their gymnasium classes or in their assembly rooms.

Because of the differences in the school systems, it would be unfair to throw these results into one large tabulation based on the frequency of the answers. For this reason it was decided to average the percentage of items checked in each of the four schools. Thus each school program enters into a final result which is weighed to give all schools an equal importance regardless of the number taking the questionnaire.

In the construction of the questionnaire an indirect approach was used.[1] This method gave results which are thought to be more accurate than the ordinary direct question type. In the space provided for additional reasons, a great many students indicated that they were writing actually how they thought their friends would be helped.

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* Paper read before the Research Section Meeting, Middle West District Association Convention at Wichita, Kansas, March, 1933.

[1] A copy of the questionnaire as it was used is presented. This was mimeographed on a single sheet (8½" x 14").

PUPIL OBJECTIVES

Check: Boy......Girl......Age......City....................Grade........

Directions:

If you were to try to convince your best friend to take Gym, which of the following reasons would you use? *Do not check any of the statements that you do not believe.* Encircle the number of all statements that you would use.

Gym will:

1. Teach some aids in self-defense.
2. Give you muscular coordination.
3. Help you make a school or class athletic team.
4. Give you a chance to take showers.
5. Get you out of a study hall period.
6. Help make you popular with the rest of the students.
7. Teach games and sports you will play after you graduate from school.
8. Teach games and sports you want to play in school.
9. Be an easy way to get your exercise.
10. Teach you how to become a leader.
11. Usually be fun.
12. Promote physical efficiency.
13. Help you grow.
14. Teach self-control so you will not "lose your head."
15. Promote the development of students into ladies and gentlemen.
16. Make you more graceful.
17. Develop a strong heart and good lungs.
18. Build up your resistance to disease.
19. Teach you to be a "good sport."
20. Teach cooperation by team work in games.
21. Give you better physical appearance, or "form."
22. Give you a strong, well-developed body.
23. Teach you personal hygiene.
24. Help in reducing.
25. Teach things which will help you get along better with your friends and other students.
26. Help you get big muscles.
27. (For girls only). Give you a chance to do things like boys.
28. (For boys only). Keep you from being considered a "sissy."
29. Teach you "to play the game" and thus be better able to stand the "gaff" of later life.
30. Develop good posture.
31. Teach you good physical habits.
32. Furnish a chance to play.
33. Teach you first aid.
34. Help you become healthier.
35. Teach you many good stunts and tricks.
36. Help to get you in good "condition" physically.
37. Give you a chance to make your friends and parents proud of you.
38. Give you a chance to do some things you can do well.
39. Correct some of your physical defects.
40. Break up your school day so you can study better.
41. I did not like gym at first but I like it now.

Fill in any reasons not given above for wanting your friend to take Gym:

1.
2.
3.

Check the statement which applies to your case.
1. I have never taken Gym.
2. I take Gym only because it is required, or for the credit.
3. I am taking Gym because I like it, and not because it is required.

These questions have been divided into groups by two different methods. In the first classification, all the items are listed as either physical or social objectives. A few questions could not be so classified, thus leaving a third group which was called the "remaining unclassified items." In the final questionnaire there are eighteen items dealing directly with the physical body or condition, eighteen items concerning the individual's social contacts, and three items which could not be validly called either physical or social. This grouping can be noted in column B of the Boys' and Girls' Ranked Item List.

The second classification of questions was based on the actual results. In looking at these data from the standpoint of gender, we find that there are three types of questions: those for which the boys show a marked preference, those which the girls prefer, and those which seem to be of a neutral nature. If one set of answers indicates that 10 per cent more boys than girls in three schools marked the item, it was classed as a masculine preference. Using the same criteria, the girls' questions were picked, and those still remaining were classed as a neuter group. It should be noted that an item appearing in the boys' list does not indicate that the item is excluded from consideration by the girls.

Gym will:

Masculine:

1. Teach some aids in self-defense.
10. Teach you how to become a leader.
12. Promote physical efficiency.
13. Help you grow.
14. Teach self-control so you will not "lose your head."
15. Promote the development of students into ladies and gentlemen.
17. Develop a strong heart and good lungs.
18. Build up your resistance to disease.
22. Give you a strong, well-developed body.
23. Teach you personal hygiene.
25. Teach things which will help you get along better with your friends and other students.
26. Help you get big muscles.
31. Teach you good physical habits.
36. Help to get you in good "condition" physically.
37. Give you a chance to make your friends and parents proud of you.
38. Give you a chance to do some things you can do well.
39. Correct some of your physical defects.
40. Break up your school day so you can study better.

Feminine:

9. Be an easy way to get your exercise.
16. Make you more graceful.
24. Help in reducing.

30. Develop good posture.
35. Teach you many good stunts and tricks.

Neuter:

2. Give you muscular coordination.
3. Help you make a school or class athletic team.
4. Give you a chance to take showers.
5. Get you out of a study-hall period.
6. Help make you popular with the rest of the students.
7. Teach games and sports you will play after you graduate from school.
8. Teach games and sports you want to play in school.
11. Usually be fun.
19. Teach you to be a "good sport."
20. Teach cooperation by team work in games.
21. Give you a better physical appearance, or "form."
29. Teach you "to play the game" and thus be better able to stand the "gaff" of later life.
32. Furnish a chance to play.
33. Teach you first aid.
34. Help you become healthier.

In order to better visualize these data, two types of presentation will be used: (1) the items listed both high and low, and (2) all the items in a composite list based on averages and ranked according to their importance.

In the first or high-low method, items checked by 70 per cent of the pupils were called high; the low items are picked as the five listed with the smallest grade or percentage. This method shows the extremes as picked by the four schools. But like all grading systems, there exist the border line cases and the individual teachers' difference in emphasis. Fairly good agreement is shown in these extremes as picked by this method.

The second method seems to be fairly obvious and the reader is allowed to draw his own dividing lines as to the item's importance.

SUMMARY OF BOYS' 70 PER CENT OR HIGHER ITEMS

Listed by All Four Schools

Gym will:

17. Develop a strong heart and good lungs.
18. Build up your resistance to disease.
19. Teach you to be a "good sport."
20. Teach cooperation by team work in games.
30. Develop good posture.

Listed by Three Schools

2. Give you muscular coordination.
12. Promote physical efficiency.
14. Teach self-control so you will not "lose your head."
29. Teach you "to play the game" and thus be better able to stand the "gaff" of later life.
31. Teach you good physical habits.
34. Help you become healthier.

DATA

Percentage of Answers to Each Item

Schools	Boys A N*=69	Boys B N=89	Boys C N=86	Boys D N=496	Item No.	Girls A N=80	Girls B N=109	Girls C N=82	Girls D N=372
	67	66	50	39	1	34	7	66	31
	85	90	76	60	2	89	61	26	66
	78	47	80	57	3	79	66	8	59
	39	19	38	30	4	24	29	29	15
	10	13	5	15	5	3	18	43	14
	23	13	37	25	6	18	9	71	19
	61	33	59	49	7	60	45	39	49
	68	52	72	69	8	55	72	34	69
	48	38	42	39	9	62	52	51	52
	62	42	67	57	10	46	25	67	42
	41	35	44	57	11	59	74	39	56
	75	83	71	48	12	71	66	57	67
	59	47	69	49	13	41	32	29	33
	75	61	73	70	14	65	43	45	48
	48	17	100	33	15	29	18	62	22
	38	24	29	29	16	53	58	44	52
	97	90	92	70	17	79	51	43	54
	77	90	85	73	18	59	49	71	52
	91	47	93	89	19	89	90	67	85
	94	83	84	78	20	89	73	87	74
	67	65	69	50	21	56	47	74	51
	94	88	90	73	22	88	74	63	69
	48	26	37	39	23	33	25	24	36
	20	13	12	24	24	33	37	30	38
	45	38	36	35	25	34	19	26	27
	58	47	63	38	26	40	25	24	24
	0	0	3	0	27	48	30	44	38
	45	53	49	31	28	0	0	1	0
	72	75	79	66	29	74	29	88	45
	72	76	83	74	30	81	83	87	77
	81	71	71	62	31	62	52	29	55
	45	34	37	50	32	25	56	55	50
	45	35	27	25	33	28	17	63	34
	75	78	79	66	34	73	70	6	64
	49	55	53	28	35	50	66	68	52
	90	87	78	54	36	66	63	57	65
	51	27	51	32	37	30	14	33	27
	61	43	62	42	38	38	23	28	42
	80	81	78	68	39	56	72	35	69
	51	54	67	62	40	36	39	63	56
					41[1]				
	0	0	1	1	1	1	0	..	..
	6	9	3	11	2	9	21	55	26
	71	57	74	60	3	71	52	68	59
	20	30	19	25	4	15	26	62	15

* N = number of questionnaires from each school.
[1] Item No. 41 used only on questionnaire for the girls of School D.

36. Help to get you in good "condition" physically.
39. Correct some of your physical defects.

LISTED BY TWO SCHOOLS

3. Help you make a school or class athletic team.

LISTED BY ONE SCHOOL

8. Teach games and sports you want to play in school.

SUMMARY OF BOYS' LOW FIVE ITEMS

LISTED BY ALL FOUR SCHOOLS

5. Get you out of a study hall period.
24. Help in reducing.

LISTED BY THREE SCHOOLS

6. Help make you popular with the rest of the students.

LISTED BY TWO SCHOOLS

4. Give you a chance to take showers.
16. Make you more graceful.
33. Teach you first aid.

LISTED BY ONE SCHOOL

15. Promote the development of students into ladies and gentlemen.
25. Teach things which will help you get along better with your friends and other students.
35. Teach you many good stunts and tricks.

BOYS' RANKED ITEM LIST

A	B	C	ITEMS
Gym will:			
873	P	1	Develop a strong heart and good lungs.
863	P	2	Give you a strong, well developed body.
848	S	3	Teach cooperation by team work in games.
813	P	4	Build up your resistance to disease.
800	S	5	Teach you to be a "good sport."
778	P	6	Give you muscular coordination.
773	P	7	Help to get you in good "condition" physically.
768	P	8	Correct some of your physical defects.
763	P	9	Develop good posture.
745	P	10	Help you to become healthier.
730	S	11	Teach you "to play the game" and thus be better able to stand the "gaff" of later life.
713	P	12	Teach you good physical habits.
698	S	13	Teach self-control so you will not "lose your head."
693	P	14	Promote physical efficiency.
653	S	15	Teach games and sports you want to play in school.
635	S	16	Help you make a school or class athletic team.
628	P	17	Give you a better physical appearance, or "form."
585	R	18	Break up your school days so you can study better.
570	S	19	Teach you how to become a leader.
555	S	20	Teach some aids in self-defense.

529	P	21	Help you grow.
520	S	22	Give you a chance to do some things you can do well.
515	P	23	Help you get big muscles.
505	S	24	Teach games and sports you will play after you graduate from school.
495	S	25	Promote the development of students into ladies and gentlemen.
463	S	26	Teach you many good stunts and tricks.
445	S	27	Keep you from being considered a "sissy."
443	S	28	Usually be fun.
418	P	29	Be an easy way to get your exercise.
415	S	30	Furnish a chance to play.
403	S	31	Give you a chance to make your friends and parents proud of you.
385	S	32	Teach things which will help you get along better with your friends and other students.
375	P	33	Teach you personal hygiene.
330	R	34	Teach you first aid.
315	P	35	Give you a chance to take showers.
300	P	36	Make you more graceful.
245	S	37	Help make you popular with the rest of the students.
173	P	38	Help in reducing.
108	R	39	Get you out of a study hall period.
655		1	I am taking Gym because I like it, and not because it is required.
235		2	I would have taken Gym, even if it were not required.
073		3	I take Gym only because it is required, or for the credit.
005		4	I have never taken Gym.

Column A is the per mille of each item as averaged from the report of the four schools.

Column B is a list of items grouped so that P = personal items, S = social items, and R = remaining unclassified items.

Column C is the order in which the items were ranked.

SUMMARY OF GIRLS' 70 PER CENT OR HIGHER ITEMS

Listed by All Four Schools

Gym will:

20. Teach cooperation by team work in games.
30. Develop good posture.

Listed by Three Schools

19. Teach you to be a "good sport."

Listed by Two Schools

22. Give you a strong, well-developed body.
29. Teach you to "play the game" and thus be better able to stand the "gaff" of later life.
34. Help you become healthier.

Listed by One School

6. Help make you popular with the rest of the students.
8. Teach games and sports you want to play in school.
11. Usually be fun.
12. Promote physical efficiency.
17. Develop a strong heart and good lungs.
18. Build up your resistance to disease.
21. Give you a better physical appearance, or "form."
39. Correct some of your physical defects.

SUMMARY OF GIRLS' LOW FIVE ITEMS

None were agreed upon by all four schools.

Listed by Three Schools

5. Get you out of a study hall period.
6. Help make you popular with the rest of the students.

Listed by Two Schools

4. Give you a chance to take showers.
15. Promote the development of students into ladies and gentlemen.
25. Teach things which will help you get along better with your friends and other students.
26. Help you get big muscles.

Listed by One School

1. Teach some aids in self-defense.
2. Give you muscular coordination.
3. Help you make a school or class athletic team.
23. Teach you personal hygiene.
32. Furnish a chance to play.
33. Teach you first aid.
37. Give you a chance to make your friends and parents proud of you.

GIRLS' RANKED ITEM LIST

A	B	C	Items
			Gym will:
827	S	1	Teach you to be a "good sport."
820	P	2	Develop good posture.
808	S	3	Teach cooperation by team work in games.
745	P	4	Give you a strong, well developed body.
653	P	5	Promote physical efficiency.
628	P	6	Help to get you in good "condition" physically.
605	P	7	Give you muscular coordination.
590	S	8	Teach you "to play the game" and thus be better able to stand the "gaff" of later life.
590	S	9	Teach you many good stunts and tricks.
580	P	10	Correct some of your physical defects.
577	P	11	Build up your resistance to disease.
575	S	12	Teach games and sports you want to play in school.
570	S	13	Usually be fun.
570	P	14	Give you a better physical appearance, or "form."
568	P	15	Develop a strong heart and good lungs.
550	P	16	Help you become healthier.
545	P	17	Be an easy way to get your exercise.
530	S	18	Help you make a school or class athletic team.
518	P	19	Make you more graceful.
503	S	20	Teach self-control so you will not "lose your head."
495	P	21	Teach you good physical habits.
490	R	22	Break up your school day so you can study better.
483	S	23	Teach games and sports you will play after you graduate from school.
465	S	24	Furnish a chance to play.
450	S	25	Teach you how to become a leader.
400	S	26	Give you a chance to do things like boys.
355	R	27	Teach you first aid.

345	S	28	Teach some aids in self-defense.
345	P	29	Help in reducing.
338	P	30	Help you to grow.
328	S	31	Promote the development of students into ladies and gentlemen.
328	S	32	Give you a chance to do some things you can do well.
295	P	33	Teach you personal hygiene.
293	S	34	Help make you popular with the rest of the students.
283	P	35	Help you get big muscles.
265	S	36	Teach things which will help you get along better with your friends and other students.
260	S	37	Give you a chance to make your friends and parents proud of you.
243	P	38	Give you a chance to take showers.
195	R	39	Get you out of a study hall period.
625		1	I am taking Gym because I like it, and not because it is required.
295		2	I would have taken Gym, even if it were not required.
278		3	I take Gym only because it is required, or for the credit.
003		4	I have never taken Gym.

Column A is the per mille of each item as averaged from the report of the four schools.

Column B is a list of items grouped so that P = personal items, S = social items, and R = remaining unclassified items.

Column C is the order in which the items were ranked.

Up to this point, the boys' and girls' data have been treated separately. The differences in their objectives are of interest and are shown listed so that the items of greatest differences are first.

RANKED LIST SHOWING BOYS' AND GIRLS' DIFFERENCES

Difference Ranked	Ranking Boys	Ranking Girls	
			Gym will:
17	36	19	Make you more graceful.
17	26	9	Teach you many good stunts and tricks.
15	28	13	Usually be fun.
14	1	15	Develop a strong heart and good lungs.
12	29	17	Be an easy way to get your exercise.
10	20	30	Help you grow.
12	23	35	Help you get big muscles.
10	22	32	Give you a chance to do some things you can do well.
9	38	29	Help in reducing.
9	14	5	Promote physical efficiency.
9	12	21	Teach you good physical habits.
8	20	28	Teach some aids in self-defense.
7	13	20	Teach self-control so you will not "lose your head."
7	4	11	Build up your resistance to disease.
7	9	2	Develop good posture.
7	34	27	Teach you first aid.
6	19	25	Teach you how to become a leader.
6	25	31	Promote the development of students into ladies and gentlemen.
6	30	24	Furnish a chance to play.
6	10	16	Help you become healthier.
6	31	37	Give you a chance to make your friends and parents proud of you.

The listing was not carried past this point because the writer feels that unless the ranks differ by more than one-sixth of this range (of 39), the difference is not worth noting.

DISCUSSION AND CONCLUSIONS

1. In a tabulation not shown in the data sheet, 98 girls of school D were classed as taking gymnasium classes because it was required and 274 as taking these classes because they liked them. This tabulation showed that all items but numbers 1 and 5 were listed from 10 per cent to 20 per cent higher by those who were taking gymnasium classes because they liked them. The two items mentioned above were both listed 5 per cent higher by the group of 98 required students. *Those who like this type of work seem to find more benefits from the classes than those who dislike it.*

2. On an examination of the high and low lists, one finds 32 out of 40 items checked. The curious thing about this is that there are only three conflicts in these judgments. The girls in school C were responsible for the conflicts in all three items. They listed high (No. 6), "Gym will help make you popular with the rest of the students," and low (No. 2 and No. 3), "Gym will give you muscular coordination and help you make a school or class team." *Students show remarkable consistency in classifying the items into high and low groups.*

3. This consistency of classification is not shown when one considers the ideas presented in some of the individual items. For example, in the high group or near the top ranked list, one will find that gym will teach "cooperation" and "good sportsmanship." Also ranked fairly high one will notice the items of "self-control" and the teaching of the ability to stand the "gaff" of later life. Listed low one finds that "gym will help make you popular with the rest of the students, teach you things which will help you get along better with your friends, and promote the development of ladies and gentlemen." It seems that the students do not recognize similar items when the language of the gymnasium is taken away. The writer believes that the students are learning only "empty words" when it comes to present day character education in gymnasium work. These "words" are returned when asked for, but no measure of improvement in their every day life is noted by these pupils. *Improvement in the so-called character education is caught from the teacher, not taught by him.*

4. One of the objectives of physical education is to provide recreation with a carry-over to later life. With that in mind, how can this rating of about 50 per cent of the boys and girls be justified? *Half of these people think that they are not learning games and sports they will wish to play after graduating from school.*

5. The results of this questionnaire show that different schools and

teachers vary their emphasis on these points. In school A the same teacher, a man, handles all the classes for boys and girls. The percentage answers of these two groups were similar for most items. One teacher who is known to be very much of a gentleman had a 100 per cent marking of his boys to the item "Gym will promote the development of students into ladies and gentlemen." It was this loaded sample which kept the item as high as a ranking of twenty-five in the composite list. *The items as ranked seem to be an index to what we are teaching in gymnasium classes as the pupils are influenced by our attitudes and habits.*

6. *Boys seem to expect some different things than do girls from their physical education work.* Ranked first for boys is the development of a strong heart and good lungs. This item was fifteenth for the girls. On the other hand, the second item for girls is one of good posture, while this is ninth for boys. Big muscles are rated as desirable to 28 per cent of the girls while 52 per cent of the boys would cultivate them. Gracefulness is hoped for by 52 per cent of the girls and only 30 per cent of the boys.

7. One would say that boys are less conservative. The boys range their items from 11 to 87 per cent, while the girls range theirs from 20 to 83 per cent. From the fact that an average of 7.3 per cent of the boys say they are taking gymnasium work because it is required for credit, as compared with 27.8 per cent of the girls, it seems safe to conclude that more boys like gym than do girls. *For both sexes, gym work seems to be popular in all the schools except for the girls of school C.*

8. These data indicate that the items of *self-defense* and the teaching of *first aid* are both ranked lower than usually would be considered possible. Is this ranking the result of the questionnaire technique or of lax teaching in our field?

9. An interesting situation is observed in relation to the grouping of physical and social items. The girls expect to get more social benefits than do the boys. The highest ranking three items show two social items for girls and two physical ones for the boys. If one uses the first ten or fifteen items, the girls' social ranking still predominates those of the boys. It is curious to note however, that the girls list as lower the carry-over social items than do the boys. For example, Gym will: "teach self-control, help you get along better with your friends, and develop ladies and gentlemen." *It seems that our teachers of girls are stressing the social aspects of physical education more than do the boys' teachers. It also seems that the boys are getting more of these values than the girls even though their teachers do not stress the social aims.* These physical and social rankings indicate that our teachers are attempting to reach some of the broad aims of physical education.

BOOK REVIEWS

Fundamentals of Personal Hygiene. Walter W. Krueger. (W. B. Saunders Co., 1932), 291 pages. Illustrated. $1.75.

Many textbooks of hygiene have appeared in the last few years. Some of these attempt to cover the whole field of hygiene, while others limit themselves to certain specific fields of hygiene. The recent book by Krueger, entitled *Fundamentals of Personal Hygiene,* is one of the latter group. It deals solely with personal hygiene and is planned for elementary students.

The book is very readable, well arranged, and well printed. The writer has expressed himself well and presents the fundamentals of personal hygiene in an interesting and persuasive manner. Of particular note is the recording at the end of each chapter of "Health Practices to be Acquired."

It is to be regretted that, as with most hygiene textbooks, most of the material is presented in didactic form. As progress is made in health education, it is probable that we will gradually change our methods in favor of encouraging the student to learn through controlled experimentation and observation.

The subject of posture is given a full chapter, and likewise a chapter is given to a consideration of feet and their care. None would care to see these subjects slighted, although many feel that the subject of posture has recently been over-emphasized. However, although many pages are given to these subjects, we find less than three pages given to a discussion of the common cold. To the student of personal hygiene, the subject of colds is of just as great interest as is the subject of posture or the care of the feet, and we certainly know as much about colds as we do about posture. The natural interest of pupils in colds and other respiratory tract infections should be utilized to present to them all the information we have on this subject.

Particularly commendable is the chapter on "Health Fads, Fancies and Follies," and the chapter on "Prevention of Common Diseases." These deal with the practical problems of pupils and with the things they are interested in.

Chas. C. Wilson, M.D.
Director, Department of Health and Physical Education, Evansville, Indiana, Public Schools.

Handbook on Athletic Activities for Women and Girls, 1933. Prepared by the Women's Rules and Editorial Committee of the American Physical Education Association (American Sports Publishing Company, New York), 90 pages and 2 charts. 25c.

Leaders of girls in school physical education departments, on playgrounds, and in clubs of all kinds will find this *Handbook* of great value. It contains sections on track and field events, athletic games, and volleyball.

The standard rules for track and field events for girls are given in detail and special events are included which form the basis of the modern field meets for adolescent girls. A very helpful article on coaching hints for beginners makes this section very valuable to the normal school graduate and young playground instructor. An information chart on track and field events for participants is included for bulletin-board use. This gives events, equipment needed, performance, rules for measurements and some maximum performances (average standards which may be used as a basis for comparing abilities).

The section on athletic games includes the rules of many low-organized games. These are particularly adapted to younger adolescent girls and older wom-

en and can be used as coaching games for older girls in preparation for more highly organized games. Base crick, long-ball, punch-ball and soccer-baseball teach the elements of playground baseball; and captain ball, captain basketball, end-ball, Newcomb, nine-court basketball, and pin-ball are included as basketball lead-up games. Rules and methods of archery and Indian golf are given in detail. Tennis type games including American (one-wall) handball, badminton, quoit tennis, and paddle tennis provide in compact form many suggestions and facts for the busy leader. A demand for miscellaneous games has been answered by the inclusion of rules for corner kick-ball, horseshoe pitching, field touch-ball, kick touch-ball, shuffle board, bowling in mass, and duck-pin bowling.

The volleyball section offers the official rules for girls, some practice tests and methods of adapting the game to large groups of inexperienced players. Some sheets from an official volleyball score-book and a sample method of scoring will be found helpful to any coach of this game. Finally, in another very comprehensive chart are given details of volleyball rules in a compact way for bulletin-board use.

Thus in a handy volume of ninety pages the inexperienced leader has official rules and valuable suggestions for a large number of games suited to adolescent girls and older women. The experienced physical education instructor or playground leader finds this book valuable for ready reference to the rules of well known activities and a source of new ideas.

Each director of training courses for leaders of girls should know this *Handbook* and require each student in her courses to own a copy. In no other inexpensive book has so much valuable material been gathered for use by student teachers and inexperienced leaders in leading girls.

ETHEL BOWERS
Field Secretary, Girls Activities, National Recreation Association.

A JOURNEY TO MANY LANDS. Book 4, Health Readers. Williedell Schawe. (World Book Co., 1932), 197 pages. 80c.

A Journey to Many Lands is another addition to story material in the field of health education built for the fourth-grade level.

The story describes journeying into different countries, getting acquainted with native children and doing the typical things of these different countries that children would be interested in doing. There is a good deal of charm and wholesomeness in the life described and the author is careful to select as the typical activity in each country something of definite health implication. In Norway the emphasis is on skiing and out-of-door play, in Switzerland the children are interested in the use that can be made of sunshine. A small *Guide Book for Health Teaching* which accompanies the book outlines in detail the health objective that the story develops.

The material in the book is definitely built to aid in integrating health teaching in geography and history and makes interesting supplementary reading for children who are studying these different nations.

The health values are woven in through living situations and seem to occupy the natural place in the cycle of daily living of children. Also the health values cover the physical, mental, emotional, and social phases—or the whole child—with very successful touches on the emotional and social aspects.

Of its kind, the book has good values and will probably be interesting to children.

A question we must ask at all times in health education is, of course, whether the things children read about really change or influence their own way of living and whether the time spent on the things they are reading or doing is as effective in influencing their living as some other things that they might be doing. On the basis of this decision we would either be glad of a book of this

type or we would find little place for it in our real education for healthful living.

ALICE EVANS
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FUNDAMENTALS IN PHYSICAL EDUCATION. Ruth B. Glassow. (Lea & Febiger, 1932), 143 pages, 34 illus. $1.75.

This book stimulates thought about those everyday habits that "we do without thinking" and paves the way for a further conscious development of effective body mechanics. The most common movements are analyzed, simple principles of hygiene are applied, and an intelligent factor added to everyday life. This work is a stone in the foundation upon which a scientific physical education course can be built.

The author's analysis of rhythmic patterns for common motor skills, her careful dissection of composite movements into their various parts, and her help in the recognition of the principles of physics in the elements of commonplace activities, bring delight to the reader.

Although one is tempted to believe that posture is reduced to too simple terms in the discussion of what it is and then is made too complicated and elusive with the statement: "Any abnormal condition in the body . . . should be remedied before further posture correction is attempted" (page 78), yet there are many helpful practical suggestions and much plain common sense in the discussion of this subject which has been so much discussed in recent months.

In the latter part of the book most of those physical conditions which can be controlled largely through physical education work are discussed in clear, straightforward style. The book could easily be used as a laboratory manual in a course in which the activities themselves were considered the laboratory exercises.

GERTRUDE E. MOULTON
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THE ART OF THE FOIL. Luigi Barbasetti. (E. P. Dutton & Co., 1932), 276 pages. $5.00.

The author, Luigi Barbasetti, is one of the most prominent exponents in the art of foil fencing in Europe. In addition to being a master swordsman, he is also a writer of note, and an authority on the Italian system of foil fencing. His works have been translated into several languages and his system adopted by many countries.

This book fills a long felt want in teaching the art of the foil. It is an outstanding contribution and particularly adapted to young fencers as well as masters who wish to compare styles and methods of pedagogy. It has given me great pleasure to read the interesting details of Barbasetti's Italian system since it brings to mind the lessons I received from Maestro Joseph Magrini in England.

From chapter one to fifteen it is filled with a large number of illustrations and line drawings. It is very comprehensive including much worthwhile data on the fundamental positions, arranged in progressive order starting with an explanation of the weapon, the grip and various positions including the salute and other elementary movements required by all fencers.

Another chapter gives in a clear and concise manner all of the positions taken in actual fencing. Many details and phases are touched upon which a student of fencing must become acquainted with. Every page is filled with helpful and practical suggestions.

There are descriptions of the Invitation giving a very impressive explanation of each movement, and gradually entering into the more complicated phases. The Bind is explained in addition to the Disengage and all the general terms used in the execution of these movements. Step by step the author successfully guides you through these coordinating phases.

Each chapter takes up the practical application of the present-day fencing knowledge, instructions in fundamental

positions; movements and methods of applying these movements under varying circumstances. One after another, in a very sound manner, the special conditions involved in the progress are explained, demonstrated, and discussed. Fifteen chapters are given to the principles and practice of foil fencing. The author understands the elements of teaching and the book will provide sufficient information for the beginner as well as the experienced fencer. Backed by the knowledge and experience the author has had in this particular field one can look to the book for interesting ideas, sound guidance, and correct methods of executing all of the movements connected with the Italian system of foil fencing.

In the second part of Mr. Barbasetti's book, a history of fencing is given together with many fine illustrations of duels. This chapter is most scholarly, drawing as it does from a discussion of "The Struggle for Life" from the Greek and Roman soldiery up through the ages to the forms of knightly combat and then on to methods of dueling in Germany, together with discussions of the masters of last century. This is a very graphic, delightful, interesting, and instructive chapter, that is teeming with historical facts which should be the common possession of every fencer.

He hits the high spots of the history and development of fencing and in addition the manners and customs, practices and beliefs of combat with the sword through the times of ancient peoples to Egypt, Palestine, Persia, Greece, Rome, Early Germany, Medieval Europe in the days of knighthood to modern fencing with its sportsmanlike science of today.

This is the first rather complete account of the contributions of Luigi Barbasetti to the study and significance of this system of foil fencing to the American public. The book appears at a time when the art of fencing is seeking and reaching new heights.

This book will be a valuable addition to the library of every person interested in fencing and it can well be included as a reference book in school libraries because of its graphic illustrations explained in a clear concise manner and in addition it will be helpful to teachers of history, drama, and physical education.

I believe Mr. Barbasetti's work has a place of great importance in the instruction of fencing in America.

JOHN JOHNSTONE
Coach of Fencing, University of Michigan, Ann Arbor, Michigan.

TESTS AND MEASUREMENTS. Irene Palmer. (A. S. Barnes & Co., 1932), 145 pages.

Miss Palmer, in presenting *Tests and Measurements, a Workbook in Health and Physical Education* to the profession, makes a unique contribution. Her analysis of the needs which should guide teacher-training programs in tests and measurements is not radical, but the translation into a vehicle in character divergent from the usual textbook type is, so far as is known, pioneer. Undoubtedly many courses of study have been developed individually which would present similar materials and methods in an analagous way, but they have remained in local obscurity, denied to wide professional utilization or criticism.

Specifically, this workbook represents a minimum or short (one semester) course of study for teachers-in-training purporting "to interest them in the possibilities of measurement and to give them some bases for the evaluation and interpretation of tests." It is organized in two parts, the statistical "Tools of Measurement" and "Tests of Health and Physical Education."

The statistical procedures are developed in a simple and direct manner, the techniques of computation being exceptionally easy to follow, well illustrated by use of data typical of the field and reinforced by practice assignments. It is doubtful, however, whether the discussions of use or meaning, which are largely assertive, give sufficient under-

standing, to the initiate, for the selection of appropriate techniques and the subsequent interpretation of results, in view of the priority and degree of detachment of this section from the specific tests later presented. This inadequacy raises a serious pedagogical question as to the order of the two sections of the course. "Tools of Measurement" (more accurately, "Tools of Statistical Treatment and Interpretation") involve techniques which are not applicable until the raw data have been secured by test and measurement. Because of this sequence of function some instructors in tests and measurements have observed that the early plunging of students into statistical procedures is bewildering and discouraging and should be attempted only after the testing program has produced data obviously meaningless without manipulation and interpretation. If this suggestion is valid, the organization of the course will readily admit of a reversal of teaching order.

The second part first deals with general criteria and characteristics of good tests and then proceeds to a discussion of the testing program under the functional classification credited to Brace and Williams. The methods employed under each category include (1) illustration by means of many existing, "representative" tests varyingly subjected to citation, explanation, critical comment and evaluation, and utilization in practice exercises; (2) discussion of the history of development; (3) analysis of needs and purposes to be served; (4) review of methods of construction and standardization; and (5) reference to selected supplementary sources.

The selection of the tests reviewed is quite comprehensive, though failure to mention the Gates-Strang *Health Knowledge Test* and the valuable work of Rowe in Cleveland seem to be instances of vital omission. As a workbook, the varying degrees to which these testing devices have been explained and clarified may be justified, and with the supplementary materials provided in the assigned and selected readings, and those which instructors will find it convenient to supply in answer to individual or local needs, this section stands as a challenging review of the techniques now available and a fine analysis of the shortages to which the professional measuring program must address itself.

The course is concluded with chapters which summarize the possibilities for measurement and research in health and physical education and constitute an orientation quite as valuable to a critical review of the tests studied as to the forward look which they effect.

Certain additional features of this work merit special commendation. Briefly they include (1) chapter organization generally devised as lesson units, (2) definite assignments of practice problems or references supplementing the context or leading on to further materials, (3) review lessons involving traditional and new type test forms, (4) a glossary of 110 items, and (5) an annotated table of contents which, however, does not supply the need for an index which would facilitate cross reference, particularly between the testing and statistical sections.

Instances of error may also be detected, many of which it seems should have been eliminated in editing and proof-reading. It is believed that the Wood-Baldwin height-weight standards are incorrectly stated and that their general efficacy for "any child" is exaggerated. Other faults occur in poor grammatical construction, inconsistency in citation, failure to cite quotations, and in statistical inaccuracies in the use of proper symbols, correct formulae, and correct construction of graphs and their segmentation. Instances of these errors will be found in representation of normal curves which reach the base line and the showing thereon of a range of only ± 3 S.D., the use of S for Σ, and assignment of ½ the cases to M + 1 P.E.

Instructors in tests and measurements in health and physical education will find much of profit in the use of this workbook, either as a basis for their own teaching or as a tool for comparative criticism of their own courses. It is essentially sketchy and occasionally doc-

trinnaire, which may necessarily be true of a workbook, but this limitation must be kept in mind as it is put into the hands of a novice. With the proper guidance and adaptations by instructors it may be found to be equally valuable for the use of students—if not, it should certainly stimulate the development of a better one.

THOS. R. GIBSON
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METHODS AND TECHNIQUES USED IN SURVEYING HEALTH AND PHYSICAL EDUCATION IN CITY SCHOOLS. Elwood Craig Davis. Teachers College Contribution to Education No. 515. (New York: Bureau of Publications, Teachers College, Columbia University, 1932.) 162 pages. $2.00.

This is a clear and well-organized report of the best available procedures for making a survey of a given situation. The methods and techniques proposed are suitable for use in surveying health service, health instruction, and physical education in city schools. Health supervision, which includes the supervision of plants and processes, has not been covered in this study. In most city school surveys these phases of the school program are surveyed by specialists who have given more attention to them than have workers in the field of physical and health education. The study is arranged in six chapters which report the nature of the problem, the historical development of survey methods and techniques in city school health and physical education, general methods and techniques, methods and techniques which are related less directly to health and physical education surveying, the uses of survey forms, and the summary and conclusions.

The plan of procedure followed in the evaluation of the general methods and techniques was to prepare a list of general methods and techniques from four general sources: (1) city school survey reports from 1910 to 1931; (2) interviews with workers in research; (3) the literature dealing with educational and exact research; and (4) suggestions of experienced surveyors in health and physical education.

This list of methods and techniques was divided into four categories for the purpose of facilitating consideration. These categories were: (a) Sources of Survey Data; (b) Methods of Collecting Survey Data; (c) Methods of Interpreting Survey Data; and (d) Methods of Reporting Survey Data.

These methods and techniques were then evaluated by four juries of experts which were made up of the following personnel: Jury 1, five directors of health and physical education in city schools; Jury 2, six special surveyors in health and physical education; Jury 3, five directors of educational surveys; and Jury 4, four experts in educational research. The criteria that the members of Jury 1 were asked to use in evaluating the methods were desirability and practicability; Juries 2 and 3 scored each method in the degree to which it was desirable, practical, and efficient; and Jury 4 scored each method in terms of the degree to which it was acceptable in research. A survey method or technique which was entirely acceptable in light of these criteria was given a score of 10. A method or technique which was entirely unacceptable was given a zero score.

The methods and techniques included under each of the four categories have been arranged in the order of the median scores assigned to them by the ratings of the twenty experts. The author has provided a description and discussion of each of the methods and techniques which were indicated to be of value by the rating of the experts. In the appendix is included a complete set of forms which may be used in making a city school survey of health and physical education.

The study does not claim that the values assigned by the experts on the juries to the forty-nine methods and techniques are conclusive and final. It is believed, however, that the ratings are of practicable value. It is also pointed out that there is a need for bet-

ter measuring instruments in health and physical education, and that there is a real need for more definitely established and accepted standards in this field.

This report has been carefully and accurately prepared. It fills a real need in physical education in that it provides a definite and evaluated statement of the methods of making a survey of physical and health education in city school systems. It should prove of value not only to persons from outside a city who are engaged in making a survey, but also to directors and teachers of physical education in city school systems who wish to study their own situation.

J. R. Sharman
Associate Professor of Physical Education, University of Michigan.

Physical Therapy in Infantile Paralysis. Arthur T. Legg, M.D., and Janet B. Merrill. Reprinted from *Principles and Practices of Physical Therapy.* (W. V. Prior Company, Inc., 1932.) 88 pages.

The presentation of a book dealing with the medical, orthopedic and physical therapeutic procedure is very timely. It is born under very serious conditions—the lack of efficiently trained physiotherapists and physical therapy technicians in every nook and corner of our country. As a rule they are located or confined to the larger areas and consequently the people in the smaller communities are without this valuable medical procedure. To the general practitioner, untrained in orthopedic and physical therapy, the therapeutic value is lost. The importance of such a book cannot be overestimated.

The information contained between its covers gives a very clear and concise analysis of the various stages of poliomyelitis, i.e., first or acute stage, second stage, third or convalescent stage, and fourth or chronic stage, as well as the treatment in each stage, emphasizing the importance of orthopedic and physical therapy procedures in the third and fourth stages. The book is profusely illustrated showing the different types of deformities and the apparatus for the prevention and correction of them.

Practically half of the book is devoted to an extended treatise on the intelligent use of physical therapeutics and its place in the treatment schedule of poliomyelitis and what can be expected from physical therapy. A detailed description of the technic in muscle training, which is so essential in the after treatment in this disease is also included.

This is an invaluable book for all those who are interested in the orthopedic and physical therapeutic values and well worth the space it would occupy in anyone's library, be he or she technician, nurse, physician, or physical therapist.

W. C. Freeman
Associate Professor of Physical Education and Director of Physical Therapy, Ohio Wesleyan University.

Play Gymnastics. L. L. McClow, and D. N. Anderson. (Mimeographed.) (Y.M.C.A., Chicago, 1932.) 137 pages. $3.00.

The book may be listed as a companion to the author's earlier book entitled *Tumbling Illustrated.* It is published in mimeographed form and presumably will be published in printed form later. It appears to the reviewer that the book is mistitled. A much more appropriate title would be "Apparatus Stunts Illustrated."

The Table of Contents gives us an accurate picture of the nature of the book. It lists activities on the following types of apparatus: Springboard, Buck, Side Horse, Long Horse, Parallel Bars, Elephant, Low Horizontal Bar, Ropes, Traveling Rings, Horizontal Ladder, Balance Beam, Stairs, plus several others with combinations of the same. It contains a total of approximately 800 stunts of which 728 are illustrated. The illustrations are of the familiar stickmen type. The illustrations, it might be said, are splendidly done by Mr. D. N. Anderson. The book also contains short chapters dealing with

lesson preparation, protection from injury, and exhibition.

Mr. McClow and Mr. Anderson have made a splendid contribution to the literature on physical education. They have done a job, which in the present writer's estimation, should have been done a long time ago. It is to be hoped that the authors will see fit to revise the material and publish it in printed form.

S. C. STALEY
Director of Physical Education, University of Illinois, Urbana, Illinois.

TEXTBOOK OF SOCIAL DANCING. Agnes Marsh and Lucile Marsh. (J. Fischer & Brother, 1933) 132 pages. $2.50.

This book is written in most interesting style and is very practical. Part I deals with the theory of dancing covering the history of social dancing, its current problems, and its educational values. Part II covers its techniques in a detailed manner. Part III deals with social aids such as the etiquette of dancing, Paul Jones, the elimination dance, and the dancing game. Part IV covers parties—first as to technique, and later describing a party program for each month of the year. Part V tells how to teach the social dance and outlines definite lesson plans for the teaching of children, also for the teaching of adults.

The book contains attractive illustrations. Recreation leaders, teachers, and all who are interested in social dancing will find it of real value.

HELEN C. PAULISON
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FOLK FESTIVALS FOR SCHOOLS AND PLAYGROUNDS, Mary Effie Shambaugh. (A. S. Barnes & Co., 1932) 160 pages. 59 illustrations. $3.00.

Miss Shambaugh in her *Folk Festivals for Schools and Playgrounds* has made a real contribution to the physical education and folk dancing world. The descriptions, diagrams, and illustrations help to make the work most understandable. The pictures of the people give a vivid idea of the costumes and how they should be worn. The music which accompanies all of the festivals is vivacious, brisk, and full of spirit. It is not so complex but that any musician could play it.

The book is divided into six parts, each part having a history of the dances or festivals following. This explanatory part is most fascinating and picturesque. The bibliographies, which follow at the close of each part, are especially complete and helpful. The one accompanying Organization of Folk Festivals deals with costumes, customs, stagecraft, and ceremonies and is material all physical education and playground teachers are glad to have.

The different parts of the book are divided as follows:

1. Organization of Folk Festivals
2. Feasts of the American Sioux Indians
3. Fiestas of the Spanish and Mexicans in California
4. Folk Gatherings of Central Europe
5. Folk Gatherings of Southeastern Europe
6. Festivals Based on Folk Tales

A division is made of the material for the intermediate and junior high school, senior high school, and College and University Festivals. This should be of great assistance in making selections of festivals for these different age levels. The book is fascinating reading, is complete in its content, and would be most valuable in one's library.

RUTH ROBINSON
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INDOOR AND COMMUNITY GAMES. Sid G. Hedges (J. B. Lippincott Co., 1933) 160 pages. $1.50.

It has already been sufficiently demonstrated, and for obvious reasons seems to follow, that times of depression are a great boom to social-game parties. Those who find themselves confronted with the problem of planning and directing such parties are as a rule quite sufficiently

familiar with the difficulties involved, and hence always welcome new materials which may be utilized in making those occasions most enjoyable for all. The author of this book has shown commendable originality both in his selection and presentation of the games themselves. He has included 350 social and indoor games and stunts under 11 game divisions proper, with a final brief additional chapter on "Forfeits." His other divisions are as follows:

I. Ice-Breaker Games	VI. Musical Games
II. Moving-About Games	VII. Sitting-Still Games
III. Boisterous Games	VIII. Team Games
IV. Spectator Games	IX. Strength and Agility Games
V. Brain-Test Games	X. Surprise Games
	XI. Race Games

These various divisions are intended to accomplish the usual ends to be sought in a program of social games. In the first place the author introduces games that are to be used for purposes of (1) getting people acquainted and into a playing mood. Thereafter follow games which are (2) fairly lively, (3) those in which much energy is needed, (4) those in which entertainment of others is the only end to be sought, and then (5) those games which are introduced for their mental diversion and interest. (6) Singing and musical games are presented for their popular appeal. Still other games are introduced (7) to offer particularly "restful contrasts after strenuous games." (8) There are opportunities provided in certain games offered for all players to take part as members of teams. (9) A number of feats are proposed for their interest to those who attempt them as well as for the amusement of spectators. Moreover these often prove to be genuine performance-ability tests. For certain appropriate occasions much mirth results from (10) victimizing someone in trick stunts and the author has included some well-selected suggestions for this purpose. A very excellent selection of (11) humorous and entertaining relays, contests, and stunt races is also offered. Finally the author has provided for (12) penalties to be evoked or imposed upon those defaulting in the performance of tasks established by certain games.

In his explanations of the games which have been selected, the author is to be congratulated for his fine, practical, straight-forward, easily followed and informal method of presentation. As a good social-games leader often does, he plunges immediately into the task of presenting his games with the least preliminaries or, as one might say, with the very minimum of introductory material. While it may be true that the book is inexpensively bound, and a second quality of paper has been used, nevertheless the printing is good and the sale price is sufficiently reasonable to perhaps make this something of an advantage. No references or bibliography are offered. Even though the choice of titles for some of the chapter heading might not in every case be entirely agreed upon as the best (i.e., II, Moving-About Games; VII, Sitting-Still Games; XI, Race Games, etc.) nevertheless the idea for the type of games and the uses for each of these divisions is very good and after all that is by far of the greatest importance. The book is a very much worth while addition to the material available on games of this nature and is to be recommended for the purpose it is intended to serve.

Norman Frederick Kunde
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